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36 R. A. Johnson

No. XXXI. APRIL, 1860. Price 4s.

QUARTERLY JOURNAL

OF

MICROSCOPICAL SCIENCE:

INCLUDING THE TRANSACTIONS OF

The Microscopical Society of London.

EDITED BY

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AND

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WITH WOODCUTS AND LITHOGRAPHIC ILLUSTRATIONS.

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LONDON:
JOHN CHURCHILL, NEW BURLINGTON STREET.

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TRANSACTIONS OF THE MICROSCOPICAL SOCIETY OF LONDON.

JOURNAL OF MICROSCOPICAL SCIENCE.

ORIGINAL COMMUNICATIONS:

TRANSLATION:

TRANSACTIONS.

List of DIATOMACEÆ *occurring in the neighbourhood of Hull.*
By GEORGE NORMAN, Esq., Hull.

(Communicated by Dr. Lankester. Read January 11th, 1860.)

FOLLOWING the example set by Mr. Comber, in his excellent "List of Diatomaceæ, of the neighbourhood of Liverpool" (Transactions of the Historic Society of Lancashire and Cheshire.—Vol. xi.), I have, in the following Paper, attempted to give as complete a list as possible of the Diatomaceæ of Hull and neighbourhood.

In so doing, I have not been so much influenced by the desire to make the paper of so much interest to Diatomists in general, as to compile a list which will be found serviceable to those who may wish to study and collect the forms occurring in this particular locality. Apart from this, however, the list may have its use (as far as it goes) in being a record of the local distributions of these beautiful forms.

On referring to Mr. Comber's list, it will be seen, that Liverpool and neighbourhood furnishes 257 species—a large number certainly, but falling considerably below the number detected in this locality. This may be partly owing to the area included in my list, being somewhat larger than the limit taken by Mr. Comber; nevertheless, I may fairly say, that the neighbourhood of Hull is peculiarly rich in Diatomaceæ; furnishing, as it does, nearly 400 species.

It may be here remarked, that (with the exception of one haul off Flambro' Head) dredgings on our coast are untried. Sand gatherings which have yielding Dr. Donkin and others so many novelties have also been scarcely tried—These two methods, if properly carried out, would in all probability considerably increase the number of species.

It is also very likely that I have overlooked many forms which would otherwise have been recorded, had the time of

observation extended over a longer period of time. The following species were collected by myself (with the few exceptions I have mentioned) within the short period of little more than three years.

It may perhaps be objected to, that species have been included which strictly speaking have not occurred in this neighbourhood. I allude here to the various forms collected from Ascidians taken from Oysters, dredged some 30 miles from the Humber mouth; but when I state that these Ascidians may always be found on Oysters in the Hull market during the winter months, I think the objection is overruled. Again, I have thought proper to include one or two species collected in the Docks from the bottoms of vessels recently arrived from abroad. In so doing, my object has been to point out this source for many interesting forms, and to stimulate others to examine vessels arriving in our various shipping ports. *Diatoma hyalinum* and *Hyalosira delicatula* have occurred to me copiously in such localities.

I have already stated, that—with few exceptions—the species enumerated in the following list have been collected and identified by myself, consequently I alone am responsible for the correctness of the same.

The exceptions are the species and localities furnished by Mr. Robt. Harrison, and Dr. Munroe, to whom my best thanks are due.

It will be seen that I have included the Genera *Rhizosolenia, Dicladia, Chætoceras, Syndendrium,* and *Bacteriastrum,* which may or may not with propriety be considered as true Diatomaceæ. They are however, in my opinion, so closely allied that I have not hesitated to admit them.

EPITHEMIA, Kützing.

E. turgida, Sm.—Not uncommon. Risby Pond. Peat Deposit, Hornsea. Plentiful in a pond, Stepney Lane.

E. Westermanii, Sm.—Rare. North Humber Bank, Dr. Munroe.

E. Hyndmanii, Sm.—Rare. Peat Deposit, Hornsea.

E. granulata, Kütz.—Rare. Hornsea Mere. Hornsea Deposit.

E. Zebra, Kütz.—Not uncommon. Hornsea Meer. Driffield. River Hull, Wawne.

E. Argus, Sm.—Rare. Hornsea Deposit.

E. alpestris, Sm.—Rare. Hornsea Deposit.

E. proboscidea, Kütz.—Local. Tetney Lock. Hornsea Deposit.

E. Sorex, Kütz.—Rare. Pond in Stepney Lane, copious.

E. Musculus, Kütz.—Not uncommon. Brackish marsh, Tetney Lock. Timber Pond, Victoria Dock. Ditch near Stoneferry.

E. constricta, Sm.—Rare. Brackish marsh, Tetney Lock. Brackish Ditch near Stoneferry. North Humber Bank, Dr. Munroe.

E. gibba, Kütz.—Not unfrequent. Risby Pond. Driffield. Brackish pond near Tetney.

E. ventricosa, Kütz.—Not uncommon. Risby Pond. Brackish marsh, Tetney Lock. Salt-water Ditch, Stallingbro'. River Hull, Wawne. Hornsea Peat.

E. marina, Donk.—Rare. Sands, Hornsea.

Cymbella, Agardh.

C. Ehrenbergii, Kütz. — Not uncommon in fresh water. Hornsea Peat. Cottingham. Spring Ditch.

C. cuspidata, Kütz.—Not uncommon, but never abundant. Saltersgate. Harrogate. Frequent in gatherings, Cottingham.

C. affinis, Kütz.—Local. Abundant in a gathering near Harrogate.

C. maculata, Kütz.—Frequent. Pure, in a ditch running from Anlaby to Hessle Road. Beverley. Cottingham. Haltenprice. Reservoir Waterworks.

C. Helvetica, Kütz.—Rare. Rocky stream, Saltersgate. Spring Ditch. Market Weighton Canal.

C. Scotica, Sm.—Rare. Rocky stream, Saltersgate. Ditch, Cottingham Road.

C. ventricosa, Kütz.—Not uncommon. Pond, Skirlaugh. Inglemire Lane, near Cottingham, pure. Benningholme.

Amphora, Ehrenberg.

A. ovalis, Kütz.—Common in almost every fresh-water gathering; more rarely in brackish water.

A. affinis, Kütz.—Not unfrequent in brackish water. Ditch near Stoneferry. Humber Bank. Tetney.

A. hyalina, Kütz.—Frequent. Humber. Pure in a salt-water pool, Grimsby.

A. salina, Sm.—Not unfrequent. Victoria Dock Timber Pond. River Hull, near Stoneferry.

A. tenera, Sm.—Common in salt-water Pools and Ditches. Dairycoates under Railway arch. North Humber Bank, pure. River Hull, near Stoneferry.

A. costata, Sm.—Rare. Behind the Garrison, Dr. Munroe.

A. minutissima, Sm.—Fresh water. Cottingham. Beverley Parks, near Woodmancy. Springs, Newbald.

A. n. s. with capitate extremities. Growing on wall in a Fern and Orchid stove.

A. quadrata, Greg.—Rare. Ascidian gatherings.

A. arenaria, Donk.—Rare. Sands, Hornsea.

A. littoralis, Donk.—Rare. Sands, Hornsea.

A. crassa. Greg,—Rare. In Ascidians.

COCCONEIS, Ehrenberg.

C. Pediculus, Ehr.—Very common in most fresh-water gatherings. Pure, Cottingham Beck, on *Cladophora* Waterworks reservoir. Beverley. River Hull. Cottingham, &c.

C. Placentula, Ehr.—Very frequent. Cottingham. Haltenprice. Wawne. Pure on *Cladophora,* Harrogate. Waterworks reservoir.

C. Thwaitesii, Sm.—Rare. Ditch, Cottingham-road. Springs, Newbald.

C. Scutellum, Ehr.—Common on *Cladophora rupestris.* Filey. Flambro' Head. Stomachs of Ascidians.

C. diaphana, Sm.—Rare. Hornsea Deposit. Brackish ditch, Marsh Chapel.

COSCINODISCUS, Ehrenberg.

C. minor, Ehr.—Rare. Ascidians.

C. minor, Kütz.—Rare. In a slide from the Humber gathered by Dr. Redfern in 1853, and sent to me by Professor Arnott.

C. radiatus, Ehr.—Common in Ascidian gatherings. Dredgings off Flambro' Head. Rare in Market Weighton Canal. Rare in Reservoir Waterworks, where the salt water unfortunately sometimes has access.

C. eccentricus, Ehr.—Very common in Ascidian gatherings, often very pure.

C. Concinnus, Sm.—Frequent in Ascidians, sometimes very large.

C. perforatus, Ehr.?—Ascidians. Very rare.

C. ovalis, Roper.—Very rare in Ascidian gatherings.

C. Normani, Greg.—Frequent in Ascidian gatherings.

C. Labyrinthus, Roper.—Very rare in Ascidian gatherings.

C. centralis, Ehr.—Frequent in Ascidians.

EUPODISCUS, Ehrenberg.

E. Argus, Ehr.—Not unfrequent in Ascidians. Dredgings off Flambro' Head.

E. fulvus, Sm.—Very plentiful and fine in Ascidians.
E. crassus, Sm.—Ascidian gatherings. Sands, Hornsea. Stoneferry.
E. sculptus, Sm.—Rare. Ascidian gatherings.
E. tesselatus, Roper.—Very abundant and fine in Ascidians, sometimes nearly pure.
E. Ralfsii, Sm.—Rare. Ascidian gatherings.

ACTINOCYCLUS, Ehrenberg.

A. undulatus, Kütz.—Very frequent in Ascidian gatherings. Stoneferry, rare. Dredgings Flambro' Head. Filter Waterworks, rare.

TRICERATIUM, Ehrenberg.

T. favus, Ehr.—Very rare in Ascidians. Single frustule, Walls of Victoria Dock.
T. alternans, Bailey.—Frequent in Ascidian gatherings.
T. striolatum, Ehr.—Rare in Ascidians.
T. armatum, Roper.—Very rare in Ascidians.
T. undulatum, Brightwell.—Very frequent in Ascidians.

CYCLOTELLA, Kützing.

C. Kützingiana, Thwaites.—Very common in fresh and brackish water. Spring Ditch. Cottingham. Tetney. Stoneferry. Market Weighton Canal. Wawne.
C. minutula, Kütz.—Frequent in the Hornsea Deposit.
C. operculata, Kütz.—Frequent in clear Ditches. Spring Ditch. Cottingham. Ripley. Pure in a Drinking Trough for Poultry.
C. rotula, Kütz.—Rare. Market Weighton Canal. Hornsea Deposit.
C. punctata, Sm.—Very copious and fine in a gathering made in the Market Weighton Canal, near the River Foulney, attached to *Myriophyllum* and *Potamogeton.*
C. Dallasiana, Sm.—Rare. In a ditch running from Stoneferry to Sutton.

CAMPYLODISCUS, Ehrenberg.

C. costatus.—Frequent. Spring Ditch. Plentiful in an Iron spring, Haltenprice. Springs, Cottingham. Springs, Newbald. Market Weighton Canal. Hornsea Deposit.

C. Hodgsonii, Sm.—Not unfrequent in a Dredging made off Flambro' Head.

C. spiralis, Sm.—Not unfrequent in boggy places. Iron spring, Haltenprice, copious. Boggy place, Skirlaugh.

C. cribrosus, Sm.—Not unfrequent in salt-water Pools and Ditches, Humber Banks. Market Weighton Canal. Marfleet.

C. parvulus, Sm.—Rare. Ascidian gatherings.

C. decorus, Bréb.—Rare. In an Ascidian gathering.

Surirella, Turpin.

S. biseriata, Bréb.—Not uncommon in fresh and even in brackish water. Cottingham. River Hull. Market Weighton Canal. Wawne Ferry.

S. linearis, Sm.—Not unfrequent in fresh-water localities, but always sparse. Cottingham. Beverley Parks. Wawne Ferry. Hornsea Deposit. Market Weighton Canal.

S. turgida, Sm.—Very rare in brackish water. River Hull, northward of Stoneferry. North Humber Bank, Dr. Munroe.

S. splendida, Kütz.—Not frequent. Spring Ditch. River Hull, near Stoneferry. Market Weighton Canal.

S. nobilis, Sm.—Not unfrequent. Hornsea Deposit. Cottingham. Market Weighton Canal. Stoneferry, &c.

S. striatula, Turp. — Not unfrequent in brackish water. Stallingbro'. River Hull, near Stoneferry. Humber Banks. Market Weighton Canal.

S. Gemma, Ehr.—Very frequent in salt-water Pools. North Humber Bank. River Hull, Stoneferry. Quite pure at Patrington. Breakwater near Hessle. Pure Humber Banks, Mr. Robt. Harrison.

S. fastuosa, Ehr.—Rare. Ascidian gatherings.

S. Craticula, Ehr.—Very rare in the Hornsea Peat Deposit.

S. ovalis, Bréb.—Not unfrequent in brackish water. Stallingbro'. Small Ditch near River Hull, above Stoneferry. Hornsea Deposit. Ditch running from Anlaby to Hessle Road.

S. panduriformis, Sm. — Not unfrequent in fresh water. Skirlaugh. Nettleton. Market Weighton Canal. Pure near Harrogate.

S. Brightwellii, Sm.—Not unfrequent in brackish water, but never abundant. Outlet Hornsea Meer. Hornsea Deposit. River Hull. Ditch near Stoneferry. Reservoir Waterworks. Market Weighton Canal.

S. ovata, Kütz.—Very frequent in brackish or fresh water. River Hull. Skirlaugh. Dairycoats. Nearly pure, North Humber Bank. Cottingham, nearly pure. Harrogate. Victoria Dock Timber Pond.

S. salina, Sm.—Rare. Banks of River Hull.

S. pinnata, Sm.—Not uncommon in fresh and even in brackish water, but never abundant. Risby Pond. Cottingham. Haltenprice. Ditch near River Hull. Hornsea Deposit.

S. angusta, Kütz.—Rare. Stoneferry Lane. Dr. Munroe.

S. Crumena, Bréb.—Rare. Boggy Ditch, Saltersgate. "Birk Craggs," Harrogate. Ditch at Haltenprice.

S. apiculata, Sm.—Rare. Boggy Ditch, Saltersgate.

S. minuta, Bréb.—Rare. Thornton-le-Moor, Mr. Robt. Harrison. Victoria Dock Timber Pond, Dr. Munroe.

Tryblionella, Smith.

T. gracilis, Sm.—Not uncommon in brackish water. Stoneferry. Humber Banks. Hornsea Deposit. Market Weighton Canal. Very abundant and fine in a small Ditch northward of Stoneferry.

T. marginata, Sm.—Not uncommon in brackish and fresh water. Stallingbro'. River Hull above Stoneferry. Outlet Hornsea Meer. Haltenprice. Market Weighton Canal. Pond near Stepney.

T. constricta, Greg.—Rare. Ascidians.

T. punctata, Sm.—Rare in brackish water. Market Weighton Canal. Humber Bank, in slides sent me by Professor Arnott, collected by Dr. Redfern in 1853. Pond, Stepney, Lane.

T. acuminata, Sm.—Not uncommon in brackish water. Rare in fresh water. Ditches near Stallingbro'. Cottingham. Timber Ponds, Mr. Robt. Harrison.

T. angustata, Sm.—Rare. Market Weighton Canal. Beverley Parks. Anlaby-Road, Dr. Munroe. Thornton-le-Moor.

T. apiculata, Greg.—Frequent in a gathering, Patrington.

T. Scutellum, Sm.—Very rare. North Humber Bank, Mr. Robt. Harrison.

Cymatopleura, Smith.

C. Solea, Sm.—Very common in fresh-water ditches. Skirlaugh. Hornsea Deposit. Wawne. Reservoir Waterworks. Very abundant near Cottingham. Haltenprice. Spring Ditch. Beverley Parks, &c.

C. apiculata, Sm.—Rare. Cottingham. Skirlaugh. Clay Pits, Nettleton.

C. elliptica, Sm. — Very common in fresh-water ditches. Risby Pond. Wawne. Haltenprice. Peat Deposit, Hornsea. Cottingham. Beverley. Market Weighton Canal. Spring Ditch.

NITZSCHIA, Hassall.

N. sigmoidea, Sm.—Very frequent in fresh clear water ditches. Cottingham. Risby Pond. River Hull, Wawne. Spring Ditch, very abundant. Harrogate. Beverley Parks. Haltenprice.

N. Brébissonii, Sm.—Local but plentiful in a small brackish ditch near the River Hull, above Stoneferry.

N. socialis, Greg.—Not uncommon in a Dredging, Flambro' Head.

N. macilenta. Greg.—Rare in a Dredging, Flambro' Head.

N. Sigma, Sm.—Very frequent in salt water pools and ditches. Dairycoats, under Railway arch. River Hull, frequent. Victoria Dock Piers. Grimsby. Timber Ponds, Victoria Dock.

N. spectabilis, Sm.—Rare in a brackish ditch near Stoneferry.

N. linearis, Sm.—Not uncommon. Haltenprice. Cottingham. Beverley Parks.

N. tenuis, Sm.—Very common. Haltenprice. Beverley Parks. Spring Ditch. Nettleton. Cottingham, very frequent.

N. spathulata, Sm.—Rare. On Breakwater Hessle, Mr. Robt. Harrison. Sands, Hornsea. North Humber Bank, Dr. Munroe.

N. angularis, Sm.—Not unfrequent in salt water. Timber Pond, Victoria Dock. Piers, Victoria Dock. Ascidians.

N. lanceolata, Sm.—Occasionally from Ascidians.

N. Amphioxys, Sm.—Not unfrequent, but always much mixed. Soil, Benningholme Carrs. Nettleton. Harrogate. Cottingham. Wawne. Killinghall. Market Weighton Canal.

N. vivax, Sm.—Copious in a brackish ditch near River Hull, above Stoneferry.

N. parvula? Sm.—Not uncommon in brackish or fresh water. Pure in a Pool at Withernsea. Victoria Dock Timber Pond. Cottingham.

N. minutissima, Sm.—In a trough for poultry.

N. vitrea, Nor. M. S.—Very local. In a small brackish ditch near River Hull, above Stoneferry.

N. dubia, Sm.—Very common in brackish or fresh water. Stallingbro'. Cottingham, very pure. Humber Banks. Tetney. Ditch near River Hull, above Stoneferry, abundant. Wawne. Haltenprice. Dairycoats. Pure in a ditch running from Anlaby to Hessle Road.

N. dubia Var. β Sm.—Not uncommon in fresh or brackish water. Skirlaugh, nearly pure. Clay Pit, Nettleton. Brackish ditch near River Hull. Pond in Stepney Lane.

N. bilobata, Sm.—Not unfrequent in brackish water. Pure under Railway arch, Dairycoats. Stallingbro'. Small ditch near the River Hull. Outlet, Hornsea Meer.

N. cursoria=Bacillaria cursoria, Donk.—Rare. In a sand-gathering, Hornsea.

N. plana, Sm.—Not frequent. Brackish ditch near River Hull.

N. virgata, Roper.—Rare. Sands, Hornsea. Dredgings off Flambro' Head.

N. insignis, Greg.—Rare. Dredgings off Flambro' Head.

N. Closterium, Sm.—Not unfrequent. Salt and brackish water. Humber Banks. Marfleet. Grimsby. Ascidians.

N. reversa, Sm.—Rare. Ascidians. Ditch near Stoneferry.

N. acicularis, Sm.—Not frequent. Under Railway arch at Dairycoats. Cottingham, near Mr. Wilson's Grounds.

N. Tænia, Sm.—Not uncommon. Humber Bank. Pure near Marfleet Clough.

N. palea, Sm.—Not common. Cottingham. Pure near the Waterworks, Stoneferry.

N. curvula, Sm.—Rare. In fresh and brackish water. Beverley Parks. Ditch running from Stoneferry to Sutton, Mr. Robt. Harrison.

AMPHIPRORA, Ehrenberg.

A. alata, Kütz.—Very frequent in brackish water. Humber Banks, often pretty pure. Marsh Chapel. Breakwater, Hessle. Ditch near River Hull, above Stoneferry. Victoria Dock Timber Pond.

A. paludosa, Sm.—Not unfrequent in brackish water. Ditch running from Stoneferry to Sutton. Ditch near River Hull. Humber Banks. Ditch running from Anlaby to Hessle Road.

A. "*didyma,* Sm.—Rare. Humber Banks," Dr. Munroe.

A. vitrea, Sm.—Rare. Dredgings off Flambro' Head.

A. constricta, Ehr.—Very common in brackish water. Pure in Victoria Dock Timber Pond. Marsh Chapel. Pure near Marfleet. Garrison Moat. Dairycoats, under Railway arch.

A. lepidoptera, Greg.—Rare. Dredgings, Flambro' Head.

AMPHIPLEURA, Kützing.

A. pellucida, Kütz.—Very local. Nettleton. Very pure near Cottingham, Mr. Robt. Harrison. In abundance Risby Pond, near a submerged Willow Tree. Between Spring Head and Cottingham, Dr. Munroe. Very copious and fine, Pond, Botanic Gardens.

A. sigmoidea, Sm.—Rare. Ascidians.

A. danica, Kütz.—Not unfrequent. Pure near Tetney Lock. Pure, Grimsby. Humber Banks.

NAVICULA, Bory.

N. rhomboides Var. β Sm.=*interrupta*, Greg—Very rare. In a ditch between Hedon and Paull, Dr. Munroe. Salt-water ditch at Dairycoats, Mr. Robt. Harrison.

N. amphigomphus, Ehr.—Not common. Cottingham. Wawne. Harrogate.

N. lanceolata, Kütz.—Very local. Very copious in a gathering from Beverley Parks, near Woodmancy.

N. Crassinervia, Bréb.—Not unfrequent in fresh water, but always much mixed. Nettleton. Saltersgate. Cottingham. River Hull.

N. cuspidata, Kütz.—Frequent in fresh water. Spring ditch. Cottingham. Hornsea Meer. Hornsea Deposit. Risby Pond. Pure in a Puddle near "Birk Cragg," Harrogate Haltenprice. Stepney.

N. rhynchocephala, Kütz.—Not unfrequent, but never abundant. Cottingham. Risby Pond. Harrogate. Haltenprice. Market Weighton Canal.

N. Liber, Sm.—Rare. Dredgings off Flambro' Head.

N. firma, Kütz.—Not uncommon, but always much mixed. Risby Pond. Cottingham. Haltenprice. Spring Ditch.

N. elliptica, Kütz.—Very frequent, though always much mixed. Hornsea Deposit. Springs at Haltenprice and Newbald. River Hull. Reservoir Waterworks. Market Weighton Canal. Cottingham.

N. ellipsis, Sm. M. S.—Plentiful in a gathering from the Piers, Victoria Dock.

N. Smithii, Bréb.—Not unfrequent in brackish water ditches. Ditch near River Hull. Ascidians.

N. Smithii, var. β, *fusca,* Greg.—Ascidians.

N. Smithii, var. γ, *nitescens,* Greg.—Ascidians.

N. gastroides, Greg.—Scarce. Small ditch near Stoneferry.

N. minutula, Sm.—Not unfrequent in brackish water. Stoneferry. Ditch near River Hull. Humber Bank. Marsh Chapel. Tetney.

N. Jennerii, Sm.—Not unfrequent in salt and brackish water. Humber, near Stallingbro', covering the mud for miles. River Hull, Stoneferry. Marsh Chapel. Dairycoats. Grimsby.

N. Westii, Sm.—Rare in brackish water. River Hull. Stallingbro'.

N. elegans, Sm. Local in brackish water. Very copious in a stinking marsh Tetney. Small ditch near River Hull, beyond Stoneferry.

N. palpebralis, Bréb.—Rare. Mr. Robt. Harrison vide Smith's Synopsis. South Humber Bank, Dr. Munroe.

N. Semen, Kütz.—Local. Not unfrequent in the Hornsea Peat Deposit. Cottingham. Risby Pond.

N. affinis, Ehr.—Rare. Spring Ditch. Stream at Cottingham.

N. inflata, Kütz.—Not unfrequent in fresh-water gatherings. Wawne. Killinghall. Market Weighton Canal. Beverley Parks. Frequent in Cottingham gatherings.

N. gibberula, Kütz.—Frequent in fresh and brackish water. Risby Pond. Skirlaugh. Nettleton. Cottingham. Hornsea Meer. Hornsea Deposit. Copious in a brackish marsh, Tetney. Ditch near River Hull, above Stoneferry. Wawne. Haltenprice. Spring Ditch. Market Weighton Canal.

N. amphirhynchus, Ehr.—Not uncommon, though always much mixed. Nettleton. Cottingham. Skirlaugh. Harrogate.

N. producta, Sm.—Not uncommon, though always sparse. Boggy place, Skirlaugh. Springs near Cottingham. Haltenprice. Peat Deposit, Hornsea.

N. ambigua, Ehr.—Rare. Ditch near Stoneferry, leading to Sutton. Hornsea Peat Deposit.

N. Amphisbœna, Bory.—Very frequent both in fresh and brackish water. Copious in a ditch near Stoneferry. Nettleton. Humber Bank. Cottingham. Marsh Chapel. Tetney. Copious near Harrogate. Ripley. Haltenprice. Market Weighton Canal.

N. sphærophora, Kütz.—Rare in fresh water. Haltenprice. Nettleton. Hornsea Peat Deposit.

N. tumens, Sm.—Local in brackish water. Stinking marsh at Tetney. Ditch near River Hull, above Stoneferry.

N. punctulata, Sm.—Rare in brackish water. Stallingbro'. Marsh Chapel.

N. pusilla, Sm.—Not uncommon in brackish or fresh water. Wawne. Market Weighton Canal. Small ditch near River Hull, above Stoneferry. Cottingham. Thornton-le-Moor, Mr. Robt. Harrison.

N. tumida, Sm.—Rare. In a gathering from Cottingham.

N. dicephala, Kütz.—Rare. In a ditch near the Farm House Haltenprice. Cottingham.

N. cryptocephala, Kütz.—Very abundant in almost every salt and brackish water ditch. River Hull. Humber Banks, pure. Victoria Dock Timber Pond. Market Weighton Canal. Dairycoats.

N. bacillum, Ehr.—Rare in Hornsea Peat Deposit.

N. lævissima, Kütz.—Frequent in fresh-water gatherings, though never abundant. Rocky stream, Saltersgate. Nettleton. Cottingham frequent. Hornsea Peat Deposit. Haltenprice. Wawne.

N. limosa, Kütz.—Very scarce in fresh water. Spring at Cottingham. River Hull, near Wawne.

N. Hennedyii, Sm.—Rare in Ascidians.

N. Lyra, Ehr.—Ascidians. Dredgings, Flambro' Head.

N. Lyra, var. β, Greg.—Rare, Ascidians.

N. humerosa, Bréb.—Not unfrequent in a sand-washing, Hornsea. Tetney.

N. Crabro, Ehr.—Rare, Ascidians.

N. didyma, Kütz.—Not unfrequent in salt and brackish water. Frequent in a ditch near River Hull, above Stoneferry. Marsh Chapel a good gathering. Grimsby. Abundant in Ascidians.

N. binodis, Ehr.—Very rare in fresh-water gatherings. Beverley Parks, near Woodmancy. Market Weighton Canal. Thornton-le-Moor.

N. Bombus, Ehr.—Rare in Ascidians.

N. Scita, Sm.—Very local in fresh-water gatherings. Springs at Newbald. Cottingham near Springs.

N. Barclayana, Greg.—Frequent in a sand-gathering, Hornsea.

N. mutica, Kütz.—Rare. Posts in salt water, Dairycoats.

N. libellus, Greg.—Rare, Ascidians.

N. retusa, Bréb.—Rare, Ascidians. Dredgings, Flambro' Head.

N. apiculata, Bréb.—Rare. In an Ascidian gathering.

N. bacillaris, Greg.—Local in fresh water. Cottingham. Frequent in a spring two miles north of Cottingham.

N. follis, Ehr.—Rare. Market Weighton Canal. Beverley Parks.

N. forcipata, Greville.—Not common in Ascidians.
N. lepida, Greg.—Very rare in fresh water. Spring Ditch.
N. granulata, Bréb.—Rare. In a sand-gathering, Hornsea.
N. pectinalis, Sm.—Rare. Sand-washing, Hornsea.
N. æstiva, Donk.—In a sand-gathering from Hornsea.

On the Reproductive Process in the CONFERVOIDEÆ (with part of Plate VI). By T. C. DRUCE, ESQ.

(Read January 11th, 1860.)

THE study of the reproductive process in the Confervoideæ has occupied the attention of observers so eminent, that it is with very great diffidence I venture to lay before you the present imperfect observations; but two considerations, arising one out of the other, impel me to this course. The first, that whatever may be the real importance of the facts I shall have the honour of submitting to you, they are at least recorded faithfully, and have assumed a consistency and strength I little expected at the commencement of a somewhat desultory course of study. The second is, that as the present and coming season is favorable for the observation of the resting spores, I hope to induce many more observers to regard these organisms, humble in the scale of creation, but full of the highest physiological interest, and possessed moreover of beauty sufficient to reward the mere searcher after pretty objects, for devoting to them a somewhat less desultory attention than usual. I would commence the remarks I have to offer to you by pointing out a few of the difficulties with which the path is beset in this department of research. These are of two kinds; the first, pregnant with snares for the inexperienced observer, arises from the tendency of the vital protoplasm to pseudo-organization; for it is frequently overlooked that this life-blood of the vegetable world possesses as great a formative capacity as the blastema of animal life; hence are presented many appearances otherwise unaccountable. I have seen the contents of

a ruptured cell of Vaucheria assume the form of young encysted fronds of Pediastrum so nearly, that had I not myself seen the process, I should have had no doubt in so considering them; the contents of Cladophora in like manner bear an exact resemblance to young Palmellæ. I might continue the list of these false appearances; but, not to multiply instances, I would just remark that in Spirogyra, the instant a cell is injured, or the density between the contents and the surrounding medium altered, the spires become flaccid and exhibit a disposition to separate into globular aggregations of chlorophylls, and around each will be found a transparent protoplasmic layer. As this becomes inspissated, it assumes the appearance of a true cellulose envelope, and may become produced into stellate processes; and thus the history of many phenomena assumed to be connected with reproduction may be elucidated. I have no hesitation in asserting that almost all the obscure encysted bodies of algologists are to be accounted for in this wise. Again, in decaying cells, it is not unusual to find the contents resolved into a fibro-molecular mass, exhibiting a motion very similar to the swarming in Desmideæ; this is doubtless the ordinary molecular motion, but it is very deceptive. The second class of difficulties is formidable to the physiologist and practised observer, and consists in this (in the words of the authors of the 'Micrographic Dictionary'), viz., the great apparent diversities that occur in the physiological phenomena presented by what at first appear like identical structures. I shall not touch upon these now in detail, as we shall have to dwell upon some of them at a later stage in our inquiry, but pass on to consider, first, the premises upon which, in the reproduction of Confervoid Algæ, observers may hope to arrive at a right conclusion. To do this effectually, we must, I think, first look upon the distinctive peculiarities of the class before us, as bearing upon the phenomena we should expect to find connected with their reproduction; and this we may do without departing from legitimate analogy. These are the extraordinary extent of germ capacity conferred by a single generative act, and the continued nisus to vegetative multiplication rather than to generation, so long as favourable conditions are supplied; the independent vitality of the component parts of even the higher families, and the complete individuality of the phytoids of the lower; and lastly, the great resemblance, both materially and physiologically, between the protoplasm of the Algæ and the sarcode of the lower animals. From these characteristics we may infer, first, that in many species the true generative act would be com-

paratively seldom observed; and secondly, that from the combined conditions of the nisus towards gemmation, and the multiform variableness of the plastic element concerned in these changes, we should often find the true reproductive phenomena obscured by the differing conditions and fertility of resource exhibited by those of gemmation and vegetative multiplication. The uniform simplicity of plan, upon which these orders are developed, would moreover lead us to expect a corresponding uniformity as to the organs of reproduction throughout the group, more or less completely differentiated, but still identical in function and purpose; it will, therefore, not be unscientific to consider these, first, as we find them in the highest families of the order, with the intention of inquiring how far it is probable that, to discover the truth, we must look for their homologues in the lower. If this mode of investigation be legitimate, it may both lead to the solution of the problem of the reproduction of the Confervoid Algæ, and, without pretending to account for multifarious occurrences connected with them, may enable us to discriminate between essential and non-essential phenomena. The Rhodosperms I pass by, as they possess an indication of affinities higher than any of the aquatic Cryptogamia; and would direct your attention to the Melanosperms, as represented by the genus Fucus, in which we find the provisions for reproduction to be as follows:—First, oosporanges; second, conceptacles; third, antheridia. I believe I am justified in asserting that these several organs rather appear to be evolved upon a higher type than those of Confervoideæ than to be so in reality. It has been ordained that the forests of the deep should be developed upon the Cryptogamic type; but it is evident that the ability of each cell to produce zoospores, or to become a spore or antheridium, would be here incompatible with the dimensions to which these plants attain, and to fulfil their purposes. We therefore find all the fertile cells, whether gonidial, sperm, or germ, collected together in specialized parts of the organism; but the specialization stops with the locality, the spores being extruded, whether singly or in octospores, finally without a membrane, and afterwards acquiring true cellulose envelopes, after the manner of Confervoideæ. The oosporanges are formed merely by the breaking up of the cell-contents of a mass of cells into zoospores, and the process is in every respect comparable with that of the unicellular Algæ; and although the antherozoids are developed from articulated filaments, the antheridia are budded off from these in a manner similar to the horns of Vaucheria. I would also

mention here, as a point to remember in connection with the process in Confervæ, that the antheridial capsules, though quickly dissolved, are detached with the contained Antherozoids. I hope to be able to show that a similar process in all essentials exists in Spirogyra, and, as seen by Pringsheim, in Œdogonium, and by Cohn, in *Sphæoplea annulina.* I have selected this genus Fucus—widely separated from my immediate subject—because the relation of the several organs is indubitably well known, and the fertilization by the antherozoids often observed. I shall now proceed to the Siphonaceæ, in which we have again the threefold type—gemmation by zoospores, and reproduction by spores and antheridia, as observed lately in all its details by Pringsheim. I would here remark upon two points, viz., that the hooklike antheridia and spores are both formed by pouchlike protrusions from the main filament, as if for the formation of branches; the process is therefore vegetative, until the shutting off of the contents of the new cells by septa. I mention this here because the outgrowth of the fructification renders the nature of the process evident, and it does not seem impossible that the antheridia may occasionally stop short of perfection, and be converted into the small zoospores of certain Confervæ, and that the spores themselves, up to the time of fertilization, or in default of it, may, by the amount of vegetative power inherent in them, be subdivided into zoospores, and thus account for much of the confusion at present existing between true spores and sporangia, which last I have little doubt true spores never become. In the curious Hydrodictyon, the formation of resting spores has not been discovered, but there is no doubt, from analogy, that they exist. There is, however, one point to which I would direct your attention, viz., the smaller zoospores or microgonidia, and, so far as at present known, their ultimate fate; these, after moving for some time, fall to the bottom, and become encysted in little green heaps. This I believe to occur in other of the Confervæ, and to be no less than an encysted form of the antheridial capsules; and that the fecundation of the resting spores may take place either before the formation of the spore coat at all, or in the spring when it is ruptured by their expansion. I pass over the Batrachospermæ and Chætophoraceæ, in which the generative act has not yet been witnessed, with one observation, viz., that if, as Dr. Carpenter has suggested, the setiform terminal cells of the latter be antheridia, a connecting link would be formed towards the lower Confervoideæ, in the less degree of differentiation between them and the hooklike

antheridia of Vaucheria. It will be more consonant with my purpose to consider the Confervaceæ and Zygnemaceæ together as one class, waiving any precedence in point of classification between them in virtue of their near relation one to the other in vital phenomena; and that this is nearer than is generally imagined, I desire to show, by weighing the value of conjugation (the prominent characteristic of the latter family), as a true generative act, complete in itself. I should have great hesitation in propounding an assertion so heterodox, if I were not backed by the weighty authority, Schleiden, but I truly believe that conjugation is in no case or class essential; the obvious and rough analogy presented by the coalescence of two cells having blinded many observers to the evidence upon the other side.

In reference to Spirogyra, Schleiden says, "I have observed the following cases, which prove how inessential this process really is. Two cells were combined with the papilla of a third cell, and thus arose four spores—one in each of the first-named cells, and two in the third. Three cells were combined, and the result was the formation of one spore in the space formed by the three papillæ. Again, two cells were combined; there appeared two spores, and a third spore in the cavity of the papilla. Two cells combined together, and here a spore was formed in each one. Another instance very frequently occurred, in which one cell that had a papilla, which did not combine with another, exhibited a spore formed within the cell. Finally, it sometimes happens, although but rarely, that a spore is formed without the cell having formed any papilla." This paragraph I quote entire, because it affords, in better terms than I could have described, a complete epitome of my own experience. I have only to add that, having witnessed in many cases the endochrome in the very act of transference, I am certain that the assertion of Itsighsohn, that in one cell the contents are broken up into moving spiral filaments or antherozoids, is void of foundation; in fact, that observer having been probably deceived by an injured filament, the disintegrated contents of which exhibited molecular motion,—a source of error referred to in my introductory observations. The occurrence of non-conjugatory species in these Conjugateæ is surely sufficient evidence; and when, in addition to this, we find no approximation to this process among the multitude of Confervoideæ, so closely allied in other characteristics, we may surely consider the case proved against its essentiality.

The conjugation, so far as seen among the Diatomaceæ, strengthens this view; for here we have the spores resulting

from an altered condition of two halves of a single frustule, as in Melosira and Orthosira, and probably throughout the filamentous group. The same process has been observed among certain of the Naviculæ, in Acnanthes, and other organisms; and it may, I think, be safely concluded that if conjugation were the process which, in one shape or other, the student had to discover as the true generative act among the Confervoideæ, its essential conditions would not vary; and, moreover, considering that the majority of these organisms are admitted to be unicellular, and the conditions of a true generative act consist in the union of two cells of different characteristic endowments, although each cell may produce many by internal gemmation, it is difficult to conceive that the product of this vegetative multiplication can ever result in a sperm and germ cell from the same parent. The theory I would very diffidently offer to your notice is—that as a certain definite amount of germ capacity only is conferred by each generative act, the tendency of each growth by vegetative multiplication is towards the degeneration of the organism. This is evidently true and palpable to any one who has grown Confervæ in an aquarium, where the nutritive elements are not so abundant as in their native waters. In order, therefore, to prolong this power of multiplication, two cells combine to produce one, by the mere fusion of their respective cell-contents; and in cases where two spores are formed, and, as we have seen not unfrequently in Spirogyra, after fusion the contents part again into two reproductive bodies. I would further venture to propose that the germ cells in these orders are very imperfectly differentiated, and that up to the period of fecundation there is no real difference between the preparation of the cell-contents for zoospores and real spores; and that these unfecundated spores may become encysted, and are sporangia, while those fecundated are, in all cases, in due time developed in the likeness of their parents. A curious confirmation of this doctrine here occurs to me in the only instance of conjugation, so called, among a class of animals so high as the Articulata,—one of the Trematode Entozoa, *Diplozoon paradoxum* a parasite upon the gills of certain fishes, which in its young state, Diporpa, is destitute of the organs of reproduction, but at a certain stage of their existence two previously independent individuals are partially fused into each other, and become one bi-sexual organism. Here surely we may conclude that each of these Diporpæ does not in itself possess sufficient germ capacity to become perfect, but that the united capacity of both affords the requisite accumulative power; and here there can be no question as to

where the true generative act intervenes, as the phenomenon occurs in a class so highly organized as to afford us unmistakeable ova and spermatozoa in their respective organs. Upon this plan there is nothing extraordinary in the occurrence of spores in each cell of a Conferva (as in *Spirogyra mirable,* and *Mougeotia notabilis*), or in both cells of a conjugating filament, or in a cell to which the papilla has not reached that of the one opposite. And indeed, finally, I would say that there is not anything remarkable in any spherical aggregations of endochrome within cells, for their appearance is often the precursor of decay in injured filaments. So far we have had to deal with facts well ascertained, however open they may be to difference of interpretation. I have now to present to you occurrences resting principally upon my unsupported observations. These, however, have assumed a consistency which, when coupled with my previous conviction that conjugation is not the true reproduction in Confervæ, have made me deem these observations of sufficient importance to submit to your consideration. The late Professor Henfrey mentions, in the 'Micrographic Dictionary,' as an abnormal occurrence in Spirogyra, the conversion of the endochrome in certain cells into large colourless zoospores; this it has been my good fortune to witness in so many instances, that it is impossible to regard it otherwise than as connected with reproduction. It has also presented itself in Œdogonium, and the process is as follows, in both cases. The Chlorophyll vanishes by degrees from the cells, which become at last diaphanous; though obviously still full of cell-contents, the characteristic nucleus of Spirogyra is enlarged, and the protoplasmic threads thickened and connected with nucleus-like aggregations of protoplasm at the sides; nuclei and protoplasmic threads not so definitely arranged, but still obvious, are to be seen in Œdogonium, and the contents at last break up into the large colourless zoospores above mentioned; these grow in size, become spherical, and are gradually filled with a purplish black endochrome, which at last becomes dense, though evidently granular; and finally the capsules burst and discharge minute bodies, moving actively, into the cavity of the cell; although my power of 350 diameters was insufficient to detect any cilia. They most resemble the spermatia of lichens. This I believe to be the antheridial function in Spirogyra, and so far in all essentials it agrees with the account of Pringsheim on Œdogonium, excepting that the antheridial capsules discharge their contents before leaving the parent cell; but the foregoing process, I have said, obtains also in Œdogonium, and is at first sight

difficult to reconcile with it. Recollecting, however, that in Œdogonium the ordinary zoospore is formed from the whole contents of the cell, we may conceive each characium to be the primordial utricle, full of antheridial capsules, which burst within it, freeing the antherozoids into its cavity before the dehiscence of the lid. This process I have also been so fortunate as to witness; the characium being full of globular bodies, and presenting a totally different appearance to that of the same phytoid at a later stage, when the antherozoids are swarming up to the lid, after the manner of the Desmideæ; the only difference being, that this aggregation of the antheridial capsules is discharged from the parent cell at an earlier period, and provided with sufficient vegetative life to enable it to elaborate the antheridia independently.

It further appears to me, that the generative act in Confervæ may, and probably does, take place at all periods of the year; that spores, formed by conjugation and otherwise in the spring, are fecundated at once by the antherozoids after the manner I have named; whilst in the summer, in Œdogonia the vegetative process is too active to wait for the development of the antheridia within the parent cell; the cycle of their life hurries on, and the whole aggregation of antheridial capsules is emitted as a zoospore. The resting spores only attract attention in the autumn, because their appearance is more distinctive, and they are provided with additional envelopes to enable them to withstand the rigour of winter. Other occurrences there are more difficult to account for, but the supposition that the antheridial capsules may become encysted for the winter, like the resting spores, will go far to explain it, if it may only be received. I have noticed a swarming of minute gonidia in quite young cells of Œdogonium, radient with Chlorophylls, these atoms crowded to one end of each cell as if to escape; but of this there was no probability; and perhaps, although I do not speak this upon the authority of further observations, these represented the microgonidia of Hydrodictyon, but became encysted within the parent cells. Pringsheim has noticed that encysted bodies in Spirogyra produced small zoospores. Now I have no doubt that here the encysted bodies are the large colourless zoospores; the development of the antherozoids being arrested by the approach of winter. In *Sphæroplea annulina*, in which the only difference seems to be that the primordial utricle forms one antheridial capsule, instead of subdividing into many, Cohn has witnessed the fertilization of the spores by the antherozoids resembling exactly those I have seen in Spirogyra and Œdogonium. In Chlorosphæra, Professor

Henfrey has described antheridia of somewhat higher grade, having definite tubular apertures, and discharging similar corpuscules, occurring simultaneously with the resting spores; so that hardly any doubt can remain here as to their co-relationship. I should here mention, that Professor Henfrey suggests an affinity with the colourless zoospores witnessed by him in Spirogyra. I beg therefore to disclaim any appropriation of discovery in these observations, only believing I have been so fortunate as to continue them one step further. I have seen a similar process in Cladophora, and in a small branched Conferva allied to it: the capsules were adherent after the manner of those of Œdogonium, excepting that they were affixed by a point incised, instead of rootlike processes; but the contents were freed by the dehiscence of a definite lid, and corresponded in all other respects entirely.

In *Closterium moniliferum* I have found the chlorophyll to disappear, as in Spirogyra, and the spheroidal bodies rolling to and fro in the frustule, filling by degrees with the purplish-black cell-contents, and finally bursting into antherozoids.

In the last number of the 'Microscopical Journal,' Mr. Archer has described and figured bodies apparently similar to those I have mentioned, in an abnormal Tetmemorus, but also affirms it to be a frequent occurrence in Tetmemorus, Micrasterias, and Euastrum, and he has also seen a similar phenomenon to that which Professor Henfrey describes in Chlorosphæra, in Closterium, viz., the formation of flask-shaped bodies, discharging antherozoids, which in both cases are, I would suggest, the encysted antheridia. Cohn's account of the formation of the antheridia and antherozoids in Volvox, agrees also in all main points with my account in Spirogyra and Œdogonium. In Œdogonium I have had the good fortune to witness, I believe, the actual fecundation, a drawing of which I have attempted, which has at least the merit of having been drawn from life.

These are my facts; and, if the interpretation I have placed upon them be correct, they serve to show that, in the several classes named, the fructification attains essentially to the same degree of organization as that of the higher Algæ; and as approximate occurrences have been from time to time observed in almost all of the Confervoid Algæ, the type may fairly be considered universal to the group. The summary of the foregoing is—first, that conjugation is not the generative act in organisms in which it occurs, and not essential, though it may be subservient to the preparation of true spores for fecundation. Secondly, that true fecundated spores

are never sporangia, although those unimpregnated may remain in the condition of encysted gonidia, or, under favorable circumstances, subdivide at once into zoospores. Thirdly, that the true spores are fecundated by antherozoids developed in capsules, at first themselves motile, and afterwards either inside the parent cell, as in Spirogyra, or outside, as generally in Œdogonium, freeing their contents either by the rupture of the cell-wall or the dehiscence of a definite lid. Fourthly, that the antheridia may become encysted in the autumn, as well as the resting spores, and impregnation take place either before the formation of the envelopes of the spore in the autumn, or in the spring, when these are ruptured. (See Plate VI.)

In conclusion, I am conscious how little I have performed towards the fulfilment of my programme at the outset, and how easily I may be condemned upon my own premises; but I proposed it to myself rather as an indication towards right investigation, than with any hope of completing it myself on the present occasion. Finally, I lay claim to very little novelty in the foregoing observations, my object having been rather the attempt to consolidate and connect together facts already known, than to proclaim a new thing; and I do desire to call the attention of microscopists who have no special study, to these lowly organisms, not merely that it is a favorable field for research, offering the charm of novelty and ever-changing beauty, but also because the study is full of the highest physiological interest; for from unicellular organisms is there the greatest chance of discovering the great fundamental, and as yet hidden, laws of life.

MICROSCOPICAL SOCIETY.

ANNUAL MEETING.

February 8th, 1860.

DR. LANKESTER, President, in the Chair.

REPORT *of* COUNCIL.

"IN accordance with annual custom, the Council have to make the following report:

The number of members reported at the last anniversary was . . .		276
There have been since elected .		28
Making a total of		304
This number has to be reduced by—		
Deceased	7	
Withdrawn	12	=19
Leaving a final total of . . .		285 as the present number of members of the Society.

"The Library has been increased by about 160 works, including serials—chiefly presents; 77 of them consist of catalogues of objects of natural history, presented by the Trustees of the British Museum; 14 others have been purchased with a fund arising out of the sale, to members, of the early 'Transactions,' at a reduced price, which fund it is intended shall be applied solely to the supplying the Library with such works as it may be thought desirable to add to it. There still remains a considerable surplus available for this purpose.

"The collection of objects also has received many additions.

"The arrangements for the distribution of the 'Journal' continue the same as last year."

AUDITORS' REPORT.

Dr. From February 15, 1859, to February 8, 1860. **Cr.**

RECEIPTS.				£	s.	d.
Balance from previous year				35	17	5
Entrance of members				21	0	0
Compositions				63	0	0
Annual payments—						
For 1853	£1	1	0			
1854	1	1	0			
1855	1	1	0			
1856	1	1	0			
1857	4	4	0			
1858	17	17	0			
1859	108	3	0			
1860	33	12	0			
				168	0	0
Library Account—						
Sale of Transactions	20	0	0			
Ditto by Van Voorst	2	2	0			
	22	2	0			
Subscription to Ray Society—						
Books and Binding	13	8	0			
Balance				8	14	0
Dividends on Consols				13	15	5
				£310	6	10

PAYMENTS.				£	s.	d.
By Salary of Curator, one year				6	12	6
,, Assistant-Secretary				21	0	0
Commission on Collections				12	10	6
Printing, Stationery, Postage, and Carriage				10	2	0
Microscopical Journal—						
The Editors	£123	10	0			
Delivering ditto	9	8	2			
				132	18	2
Purchase of £66 11s. 7d. Consols				63	0	0
Expense of Soirée at South Kensington Museum	106	7	4			
Received for additional admissions	77	5	6			
Balance				29	1	10
Expenses at Burlington House				9	5	0
General Balance, carried forward to next year				25	16	10
				£310	6	10

Examined with the vouchers and found to be correct.

{ JOSEPH GRATTON,
{ RICHARD BECK.

Report *of the* Library Committee *of the* Microscopical Society.

"Since the last Report, some valuable additions have been made to the Library, comprising sixteen volumes, and 143 pamphlets presented, and sixteen volumes purchased, or exchanged for old numbers of the 'Transactions' or 'Journal.' The whole of the books in the Library have been examined; fifty-six volumes have been bound; the collection of pamphlets has been classified, and bound in five volumes; and a catalogue of the whole has been prepared, printed, and presented with the 'Journal' to the members.

"The Committee draw especial attention to the presentation by W. S. Sullivant, of the United States, of seven works on Mosses, &c.; and to seventy-seven numbers of the British Museum publications, by the Trustees.

"The Committee trust that arrangements will be made at an early period to provide accommodation for the books in the rooms they at present occupy, so as to be more available to the members.

"In conclusion, they strongly recommend that the following works should be added to the Library as soon as possible: 'Der Organismus der Infusionsthiere,' by Dr. F. Stein; 'Die Kieselschaligen Bacillarien,' by F. T. Kützing; 'Mikrogeologie,' by Dr. C. G. Ehrenberg.

"F. C. S. Roper.
Geo. E. Blenkins.
J. H. Roberts.
R. J. Farrants."

The President delivered the following address:

The President's Address *for* 1860.

By Dr. Lankester.

Gentlemen,—It gives me great pleasure to address you at the close of my term of presidency, after you have heard the Reports of your Council and Treasurer, and which represent our Society in a condition which commands our mutual congratulations. At the present we have a larger number of members than at any previous time in the history of our Society. However much we may regret the withdrawal of

some of our members, the addition to our numbers more than compensates for the loss. It is, however, always a painful task on these occasions to have to reflect that our numbers are diminished by the hand of death. During the past year seven of our members have been thus removed, and amongst them you will recognise some of the earliest and most active members of our Society. They are Mr. J. N. Furze, Professor Henfrey, Mr. Andrew Ross, Mr. E. Speer, Mr. W. Stuart, Mr. Richard Taylor, and Dr. H. Rees.

Some of these gentlemen demand from me more than a passing notice; and I would first refer to Professor Henfrey, whose death at an early age we have not only to deplore as a loss to ourselves, but to science generally. Although, from disease of the lungs contracted in youth, he was never robust, he yet by unceasing industry acquired for himself a European reputation. He was originally intended for the medical profession, and studied at Bartholomew's Hospital; but the state of his health induced him to abandon the arduous duties of practice, and devote himself entirely to science. The branch of study to which his tastes led him was that of botany, and in this science more particularly he attained his great distinction. One of his earliest works was on 'Anatomical Manipulation,' which he wrote in conjunction with Mr. Alfred Tulke; this was published in 1844. About this time he was appointed Botanist to the Geological Survey of the United Kingdom; he held this post but for a short time. He was subsequently appointed lecturer on Botany at the Middlesex Hospital, and at the St. George's Hospital School of Medicine. In 1847 he published his 'Outlines of Structural and Physiological Botany;' this work was illustrated by plates executed by himself. Several of these plates were devoted to the illustration of the microscopic structure of plants, and were faithful representations of his own observations. He had at this time carefully investigated the views of Schleiden and Hugo von Mohl on the cytoblast and primordial utricle, and his work, at the time it was published, was a faithful epitome of the various observations that had been made on the histology and development of vegetable tissues. This work laid the foundations of one much more extended and complete, which he afterwards published in 1857, with the title, 'An Elementary Course of Botany, Structural, Physiological, and Systematic; with a brief outline of the Geographical and Geological Distribution of Plants.' This work, which gives the most complete view of the histology and development of plants in our language, contains a large amount of original

matter on the development of the cells of plants, and the phenomena of reproduction, more especially amongst the lowest forms of plants. Between the publication of these two works, he devoted the larger portion of his time to microscopic observations, and he published several papers on these subjects in the 'Transactions of the Linnean Society,' the 'Annals and Magazine of Natural History,' and in the Reports of the British Association. The subject to which he gave the largest share of his attention was the nature of the changes which go on during the process of the impregnation of the ovule in the Phanerogamia. Schleiden had opposed the view of Amici, that the embryo is developed from an "embryonic vesicle" contained within the "sac of the embryo," and maintained that it was formed within the pollen-tube. Henfrey, from an early period, maintained the correctness of the first view of Amici, and made a great number of observations on the subject. The whole of that part of Professor Henfrey's work devoted to the histology and reproduction of plants is well deserving the study of those engaged in the microscopic investigation of the structure and formation of plants. Mr. Henfrey contributed two papers to the Transactions of our Society—one in the fourth volume of the new series, "On some Fresh-water Confervoid Algæ new to Great Britain;" and one in the seventh volume, "On Chlorosphæra, a new genus of Unicellular Fresh-water Algæ." It was in such papers as these that he displayed his careful habits of observation with the microscope; and had his life been spared, we might have expected from him large contributions to our present knowledge of microscopic organisms. During the last five years of his life he was occupied, in conjunction with Dr. Griffiths, in the laborious task of compiling and editing the 'Micrographic Dictionary.' Mr. Henfrey undertook the whole of that part of the work which related to the microscopic structure of plants. The value attached to this great work was indicated by the speedy demand for a new edition, which was completed just previous to the death of Mr. Henfrey. We have here treasured up all that had been done for the advance of botanical science by the aid of the microscope; and our friend could hardly have left behind him a more fitting monument of his industry and appreciation of microscopic inquiry, than his own contributious to this comprehensive volume.

But besides these labours having more especial reference to our specialty, Mr. Henfrey produced many other valuable works. In 1852, he wrote a volume on 'The Vegetation of Europe,' being an account of the distribution of the princi-

pal forms of plants found in Europe. The geography of plants found in him an able exponent, and he constructed the maps and wrote the letterpress on the distribution of plants, in 'Johnston's Physical Atlas.' He also further contributed to make this subject popularly understood, by translating from the German, Professor Schouw's 'Earth, Plants, and Man.' His acquaintance with German botanical literature was extensive, and he translated into English Schleiden's 'Lectures on the Biography of Plants,' and Alexander Braun's 'Rejuvenescence in Nature,' a somewhat speculative but interesting volume, published by the Ray Society.

Although he had not the gift of free speech, his earnest desire to impart all he knew, rendered him a popular teacher in his class; and when the late Professor Edward Forbes resigned his chair at King's College, he was appointed Professor of Botany in his place. Besides being a member of our own Society, he was a Fellow of the Royal and Linnean Societies, and had the appointment of Examiner in Natural Science at the Royal Military Academy at Woolwich, and at the Society of Arts. He was of a retiring and amiable disposition, and sincerely beloved by all those who knew him in private life. He fought a brave fight, and is a bright example of what a firm will can do amidst the feebleness of habitual indisposition.

In Mr. Andrew Ross the Society has lost one of its original members, and one who has had no little share in bringing the microscope to its present perfect state. He was an optician by profession, and laboured with Pritchard, Goring, Holland, and others, to bring the simple microscope to perfection, before Mr. Lister had made his great discovery of a combination of achromatic glasses in a compound arrangement. Mr. Ross was one of the earliest makers who comprehended Mr. Lister's principles, and carried them into practice in the manufacture of compound achromatic instruments. The perfect success, however, of these glasses was attended with a defect which in some measure was a drawback to their usefulness. This arose from their use in the examination of objects covered with thin plates of talc or glass, as the corrections for uncovered objects were found erroneous for those which were covered. Mr. Ross discovered the means of correcting this defect, which consisted in separating the anterior lens of the combination from the other two, in such a way that it could be brought further or nearer to them, according to the necessity of the case. An account of this discovery and its application will be found in the fifty-first volume of the 'Transaction of the Society of Arts,' pub-

lished in 1837. This method of correcting for covered and uncovered objects is applied to all our better object-glasses, and has since received some improvements at the suggestion of Mr. Powell. Mr. Ross has also from time to time added improvements to the general structure of the compound microscope, and suggested a variety of modifications in its accessory apparatus. If we are more indebted to him for his practical talent as a mechanician, it was not because he had not the ability to contribute to the literature of his profession. We have, in fact, from his pen one of the best articles that ever appeared on the microscope. This article was contributed to the 'Penny Cyclopædia,' in 1839, and is more or less the foundation of most practical treatises written since that time. Besides this masterly article, and the paper already referred to, I am not aware that Mr. Ross has contributed anything to the literature of the microscope; but these must ever give him a place amongst those who associated with Joseph Jackson Lister, and assisted to make the compound achromatic microscope the great instrument of research it is at the present day.

Those who have been in the habit of attending the scientific societies of the metropolis during the last twenty years will all recollect the intelligent and benignant face of the late Mr. Richard Taylor. Although for the last few years he had withdrawn from the activity of London life, his decease did not take place till the beginning of last year, and he continued a member with us till his end. Mr. Taylor was not so well known as a man of science, as he was as a man of letters who sympathised with men of science. He was a scholar, and cultivated that class of literature which led him to regard with especial interest the progress of natural science. He was especially associated with those who cultivated natural history, and was for many years a joint editor, as well as printer and publisher of the 'Annals and Magazine of Natural History.' He also edited four volumes of Scientific Memoirs, which were published by him from 1838 to 1846, containing translations of valuable scientific papers from the French and German. He was also, in conjunction with the late Mr. Richard Phillips, the editor of the 'Philosophical Magazine,' from 1827 to 1832. These varied labours in connection with the literature of science, constitute for him a strong claim to our remembrance and gratitude. His connection with the Linnean Society was more close than with any other, and he acted for many years as the Assistant Secretary of that Society.

The death of Mr. Furze is one that must have caused great

pain and surprise to many of the members. He was a man in the prime of life, and carrying on a large and successful business; but in the midst of all he found time to cultivate a taste for microscopic research. Without contributing to our Transactions, he took a great interest in our proceedings; and the intelligence and energy with which he cultivated the microscope, as an instrument of research, must have done much to recommend its use amongst a large circle of his friends and acquaintance. I accidentally had a proof of this some years ago, when visiting a village by the sea-side, in the county of Suffolk, where I found Mr. Furze had been staying for a few weeks before I had arrived. I had not long been there before I heard of the impression he had produced on the minds of the villagers by his daily demonstrations, upon the sea-shore, of the microscopic structure of the creatures with which the coast abounded. I have often thought that this would form the subject for a picture to a painter of the nineteenth century—a naturalist exhibiting the wonders of animal structure through a microscope to a rural population. By such pictures the great history of our civilization might be told.

Mr. E. Speer, though not a contributor to our Transactions, was deeply impressed with the value of the microscope as an instrument of research; and, in the hope of alleviating human distress by its agency, presented, before his death, a magnificent instrument, made by James Smith, to the Hospital for Consumption and Diseases of the Chest.

I would now call your attention to the state of our library. Since I addressed you last year, several works have been purchased, and others have been presented; so that we have altogether 186 complete volumes, with about 140 pamphlets and papers of various kinds. Although the number of books is not large, they present a tolerably complete epitome of the literature of the microscope in our own language. A catalogue of those works has been prepared by the Library Committee, and was published in the Transactions for the past year; separate copies have also been printed for the use of the members. A glance at this catalogue reveals to us the curious fact that the literature of the microscope has had two distinct periods; the first period may be said to commence with the establishment of the Royal Society, in 1660. From this time to the latter end of the eighteenth century, the 'Philosophical Transactions' abound with papers and memoirs devoted to the structure of the microscope and observations by its aid; and it is on this account that I think it would be most desirable that the members of this Society

should have the opportunity of consulting these precious volumes in our own library. The works that were the result of this activity are, I believe, tolerably completely represented in our catalogue. The first to which I would call your attention is the 'Micrographia' of Robert Hooke, published in 1665, and which, considering that it was the first work devoted to the literature of the microscope, is a perfect marvel. Its illustrations and the sound observations of the author may be studied with advantage at the present day. This was followed by the works of Grew and Malpighi on the Anatomy of Plants. Although Malpighi was a foreigner, his works were published by the Royal Society of London; they consisted mostly of papers which had appeared in the 'Philosophical Transactions.' He was the first to observe the passage of the blood through the capillary vessels, and his works otherwise abound with sound observations. In 1675 the communications of another distinguished foreigner commenced in the 'Philosophical Transactions;' and we may claim Leeuwenhoek almost as an English writer. His collected works will be found in our library, and contain an astonishing variety of observations on animal and vegetable structure. During this century Swammerdam wrote his treatises on insects, and made many curious observations with the microscope on the generation of the frog and other animals.

These researches bring us over the seventeenth, and carry us on to the commencement of the eighteenth century. Here we meet with the investigations of Trembley, on the Hydra; of Lyonet, on the Caterpillar of the Goat-moth; and of Spallanzani, on a variety of subjects. The latter was the first to maintain the independent animal nature of the Infusoria, and contributed a large number of observations on the function of animal impregnation. The works of Baker and the two Adamses close the labours, as far as our library will indicate them, of the eighteenth century, on microscopic subjects.

If we now turn over the pages of our catalogue, we in vain look for the continued activity of the preceding period. Observers seemed to think the microscope had done all for science that could be accomplished by its aid. It is true, the instrument was not forgotten. There were those who believed, if its powers could be increased, much more might be done by its aid. Brewster, Pritchard, Goring, Tulley, and others, worked at the construction of lenses, in the faith that more might be accomplished by its aid than had hitherto been supposed. Here and there observers were working unnoticed. Robert Brown was laying the foundation of the science of

Histology and the laws of development in relation to the vegetable kingdom, and Ehrenberg was studying the forms of infusorial animalcules in every part of the world. It was not, however, till the production of Mr. Lister's paper in the 'Philosophical Transactions,' in 1828, that a new impetus was given to microscopical research, and a literature sprung up unrivalled in the past history of the microscope. It would be impossible for me here to attempt to analyse this literature. It includes investigations with the microscope in every branch of natural science. It contains observations on the forms of crystals, plants, and animals; it embraces the highest generalisations of physiological science, and includes countless investigations into the origin, forms, and modes of growth of organs and the ultimate parts of organs of both plants and animals. Altogether, it forms an assemblage of facts and reasonings the most imposing that has ever been presented to the human mind in the same space of time in the whole history of science. To increase the stock of this literature, to render it accessible to all inquirers, and to make it the means of educating future observers by the aid of this instrument, will, I hope, be one of the constant aims of this Society.

From the Library let us turn to the Museum. It seems to me, when we consider the little cost and facility of keeping microscopic objects, that the development of the Museum should be more an object of attention than it has ever yet been to the Society. The whole collection of objects amounts to six hundred and sixty-three, seventy-three of which have been added during the past year. If illustrated works are a source of instruction, and important as enabling one inquirer to understand the views of another, there can be no doubt that properly named specimens are of more importance. This is especially the case with the forms of minute animals and plants which are described from time to time by different authors. If collections of species named by authors could be obtained from those who have first described them, they would be of great value for reference in all time to come. When we consider that the number of specimens in our Museum is not so great as those offered in the lists of those who vend these objects, and that their maximum value is not twelve pounds, I would suggest that we should do one of two things—either abandon the idea of a collection altogether, or place it in a position more worthy the credit and dignity of the Society.

Let me now call your attention to the work of the Society during the past year. Having been hastily summoned to quit our apartments in Regent-street, at the beginning of the year, and not having a place to meet in at the commence-

ment of the session, the council have found it convenient to curtail the number of our meetings; so that during the past year we have held but seven meetings, including the *soirée* at the South Kensington Museum, and the annual meeting on the 16th of February. Perhaps I may be allowed to say a word or two, first, with regard to the *soirée*. From the circumstance of the council having determined to hold this annual gathering in the extensive rooms of the Museum at South Kensington, which were placed at their disposal by the Committee of Council on Education, it was one of the largest meetings of the kind that had ever been seen in the metropolis. About three thousand persons were present, and the display of microscopes, and their accessory apparatus, was such as had never been got together before. Upwards of three hundred microscopes, exhibiting all the forms and applications of the instrument, were displayed. Although this exhibition of the instrument, and the assemblage of so large a number of patrons, might, consistently with the objects of your Society, have been purchased by a considerable outlay of funds, it must be gratifying to you to hear that, by the judicious arrangements of your council and the liberality of individual members, this immense meeting has not only not entailed on your funds any loss, but that you have been gainers by it to a slight amount.

As the ordinary meeting-nights of the past year have been only six, including the first meeting of this year, you will not be surprised to learn that only ten papers have been read.

The first paper was by Dr. Bowerbank, "On the Organization of *Grantia ciliata*," and contained a more detailed account of the structure of this curious member of the sponge family than had hitherto been published. To Dr. Bowerbank belongs the credit of having studied this interesting family of organized beings in the most exhaustive manner; and it will be gratifying to all present to know that he is now preparing a complete monograph of the British forms of sponges, which will be published by the Ray Society for the year 1861.

Our next paper was one "On Diatomaceæ collected in the United States," by Arthur M. Edwards, Esq. Besides this paper from the other side of the Atlantic, we have had another read, "On Diatomaceæ found near Gambia, Ohio," by Professor Hamilton L. Smith. These papers are interesting, as giving an account of the distribution of the Diatomaceæ in the New World, and they have been received by our Society as a gratifying proof that our aims and objects are reciprocated and understood by scientific inquirers in America. Dr.

Greville, of Edinburgh, has communicated a paper describing several new forms of the beautiful Diatomaceous genus *Campylodiscus*. Mr. Roper, in a paper on *Triceratium arcticum*, has shown that this genus must no longer be regarded as a non-catenated form of Diatomaceæ, as in its natural state its triangular frustules are connected together as in many other forms of this family. The last contribution on Diatomaceæ is by Dr. Wallich, who, in his paper "On the Siliceous Organisms found in the Digestive Cavity of Salpæ, and their relation to the Flint Nodules of the Chalk Formation," has endeavoured to account for the presence of forms of Diatomaceæ and Desmideæ in the flints and siliceous nodules of the chalk, by their having been collected by Salpæ in their stomachs, then swallowed by whales or other large animals, and, on the death of these creatures, been deposited in the bed of the ocean, in the concretionary form in which they are now found.

We may learn from these papers how great an interest attaches to the study of the Diatomaceæ, and how some of the highest problems in the history of the life upon our globe may be solved by their study. Formed of imperishable material, and, once formed, not experiencing the decay which is the law of every other existing organism, these minute beings leave behind them the most extensive record of their existence. Not only can we examine their forms, many of which are exquisite from their graceful outline and delicate carving, but even with regard to extinct species, we may gather the history of their habits and mode of increase, and other points, from the localities in which they are found. Independent, however, of the interest which attaches to the study of the Diatomaceæ as a group of organized beings presenting us, as it were, with the first struggles of life against the physical and chemical forces of brute matter, they are capital objects with which to train the eye and mind to habits of correct observation. It is in this group of beings that the advanced microscopist seeks for the severest tests with which to try the highest powers of his object-glasses; and it is in the observation of the forms and markings of these the most delicate productions of the Creative Hand that the young microscopist will best acquire the habit of distinguishing minute differences and resemblances.

An interesting communication was read at our June meeting, from Mr. George F. Pollock, containing "Observations on Granulated Blood Discs." This paper indicates that, however well the blood-discs may have been observed,

they still present phenomena whose full significance is not yet understood, and await for their explanation further observation and reflection.

The last paper read at our meetings, and not yet published in our Transactions, was one by Mr. Druce, "On the Reproductive Process in the Confervoideæ." In this paper Mr. Druce shows that there is yet much more to be done in making out the true reproductive process in Confervoideæ. He agrees with previous authors in the conviction that the process of conjugation in this family is not necessarily indicative of a union of germ-cells and sperm-cells; and certainly in most cases of conjugation this fact has not been made out. It is not at all inconsistent with our present knowledge of the ordinary function of vegetative reproduction by the multiplication of similar cells, which I have elsewhere ventured to call "homogenesis,"* that it should assume the forms and external phenomena of true generation (heterogenesis). We see this occurring in the fact that seeds which have originated quite independent of the influence of the sperm-cell occur in many of the higher forms of plants, and that ova and viviparous spores, as in the case of the bees and aphides, are produced under the same circumstances. It is, then, an interesting field for the microscopist, to study those lower forms of vegetable life in order to ascertain what phenomena are connected with the vegetative cell multiplication or homogenetic development, and what are the forms in which the phenomena of heterogenesis are presented to us.

These are the principal subjects which have been presented for microscopic inquiry during the year. In addition to these papers, we have had two on improvements in the structure of the microscope. One of these was by Mr. Richard Beck, "On the Universal Screw." Although Mr. Beck's paper pointed out some defects in the working of the plan for obtaining a universal screw, by which the object-glasses of different makers might be used by the same body, as carried out by a committee of our Society, it is very gratifying for us to know that, generally speaking, our plan has been most successful, and that microscopists, both in this country and America, recognise the suggestions of the Society as a great boon. The other paper on the instrument was by Mr. James Smith, who, in his description of a section and mounting instrument, with other contributions which he has made to the Society, has displayed considerable skill in the invention

* Preface to translation of Küchenmeister on 'Animal and Vegetable Parasites.'

of apparatus for microscopic investigation; and should he continue to apply himself to this department of study, there can be no doubt that the microscopic inquirer will be indebted to him for further improvements in the mechanical arrangements of the microscope.

But the labours of our Society do not end here. You must not forget that the 'Journal' originated in your Society, and has been conducted under its auspices, and that the papers published in its pages are as much a part of your organization as the papers published in your 'Transactions.' For the very reason that the papers in your 'Transactions' have been less in number, those in the 'Journal' have been more, and in no year since its origin has the 'Journal' been more rich in original papers than during the past year. These papers have been eighteen in number, besides translations and a variety of communications in the form of notes and memoranda. No less than ten of these have been on the Diatomaceæ; and although some may regard this as a disproportionate space for one set of objects to occupy, it must be remembered that these organisms are exclusively microscopical, and that at the present moment they possess for the microscopist a high interest, for reasons which I have before stated.

Two of the remaining papers, by Mr. Rainey, deserve your especial attention; one "On Dental Tissue," the other "On the Starch Granule." The object of Mr. Rainey in these papers is to show that the formation of the dental tissues, as well as of the starch granule, are due to the same process as that which he has so ably shown to take place in the production of shell and other hard parts, in his work on 'The Mode of Formation of Shells of Animals,' &c. As long ago as 1840 and 1841, Harting and Link published separate treatises* on the Production of Membranes, as the result of a process of crystallization of inorganic substances in contact with organic matters; and from time to time the presence of the aggregating force of crystallization has been alluded to, as possibly modifying the results of that action which has been called cell-force. It is, however, to Mr. Rainey that we are indebted for a full investigation of this subject; and he has shown that in all cases where a considerable quantity of inorganic matter is present, as in the case of carbonate of lime in shells, and phosphate of lime in bones and teeth, that the peculiar form of the tissue is due to the properties of the inorganic matter present. In his paper "On the Starch Granule," he has car-

* See Report on Botany, of Ray Society, 1845, pp. 6, 7.

ried this view further, and endeavoured to show that the peculiar form and structure of grains of starch are due to minute quantities of inorganic matter. For this process he has adopted the term "molecular coalescence." These observations are interesting in connection with the views of those who are opposed to the cell-theory of Schleiden and Schwann, and who prefer to speak of the whole of the phenomena of the formation of the tissues of plants and animals as a process of "differentiation." In connection with this subject, a paper by Professor Williamson, in the last October number of the 'Journal,' 'On some Histological Features of the Shells of Crustacea,' is well deserving attention. He there shows that certain tissues in the shells of the Crustacea that had been regarded as cellular in their structure, are produced in a protoplasmic matter, independent of cells or nuclei. I will not, however, enter here further into the matter, but call your attention to this subject as a field inviting further inquiry, and likely to yield abundant fruits to those who have leisure and opportunity for its culture.

To Mr. Currey the pages of our 'Journal' are largely indebted for his varied contributions in the field of mycology. His 'Mycological Notes,' in the number of the 'Journal' for July, is an example of how various observations on the same series of objects may be communicated with great advantage to those who are working in the same direction. In these busy days, when so many observers are investigating the same subjects, it becomes a matter of importance to all to know what others are doing, so that no time may be wasted in re-discovering what others have done. In connection with the subject of mycology, I may also draw attention to a translation in the last number of the 'Journal,' in which M. De Bary attempts to show that a certain group of the Fungi are rather of an animal than of a vegetable nature. Although considerable doubts may be thrown on M. De Bary's conclusions, his observations indicate the interest that still attaches to the question of the limits between the animal and the vegetable kingdoms. It is only by the aid of the microscope, used by well-trained observers, that such a question can be decided; and large groups of forms belonging to the Protophyta and Protozoa present themselves for investigation on this subject. Here, too, is a district in which perhaps the inquiries of the microscopist may come in to assist the inquiry which has just been opened by one of our most distinguished naturalists as to the origin of species.* It is only

* On the 'Origin of Species,' by Charles Darwin, F.R.S.

by the microscopical observer that the question of the spontaneous generation of animals and plants can be set at rest. As far as the results of present investigation go, there seems to be no satisfactory evidence that the organisms which we call plants and animals have had any other origin than organisms endowed with vital properties similar to themselves; but as to how far any one of these organisms may differ from its predecessors through all time, we are in the dark. At first sight, it looks as if this question of the origin of species was one that must be for ever veiled from our sight; and if it had not been raised by an inquirer so competent to judge of the possibilities of our science, we might have passed by the challenge unheeded. But we have been invited to ascertain the amount of change of which each individual organism is capable, and especially to observe how far such changes impress themselves permanently on the organisms, or series of organisms, in which it takes place. If by the collation of past well-observed facts with those which present themselves before us at the present day, and allowing the largest amount of time that can be reasonably demanded, we come to the conclusion that the higher organisms could be degraded to the forms of the microscopic Protophyta or Protozoa, or that these latter could be elevated to the condition of vertebrate animals, then we ought perhaps to conclude, with Mr. Darwin, that probably all organisms are derived from a single prototype. But if, on the other hand, the amount of change we can observe either of degradation or elevation, or both, is so limited that no amount of time could account for the diversity of forms of animal and vegetable life we see around us, I think we are driven back upon the hypothesis of a special creation of species, without being committed to the special form or manner of that creation. But, whatever be the direction in which our opinions lead us, let us not be hasty in the interpretation of the facts which are presented to us. Let us observe carefully and cautiously, and record our observations faithfully, in the full confidence that the Creator has so endowed the human mind, that it will in the end reject all that which is false, and only hold that which is true.

I now call your attention to two papers of high interest, on the microscopic structure of the nervous system; the one by Messrs. Turner and Lister, of Edinburgh, the other by Mr. Lockhart Clarke, of London. To the latter gentleman we are indebted for our knowledge of a method of preparing nervous tissue for examination, which has resulted in a much more accurate knowledge of the details of the structure of the

nerve tubes and cells than has been hitherto known. I need not tell you, perhaps, that there is yet much to be learned with regard to the functions of the nervous system; and that, whatever advances the physiologist may make in this direction, the real relation between function and structure will only be made by the microscope. Here, then, is a subject for some of our younger friends to pursue. The fact is, in whatever direction we turn our eyes, there is still work to be done; and I have often thought it would be possible for this Society to imitate the proceedings of the great French Academy, and appoint committees to report on researches or on subjects demanding research, which would give an impetus and direction to an amount of activity and energy that is now too often unproductive. It has been the reproach of our country that, whilst undoubtedly we have the finest instruments in the world, our contributions to micrological science are not at all in accordance with our superior opportunities of observation. I hope our Society, as it increases in numbers, will do more and more to wipe away this reproach. I hope to see our 'Transactions' increasingly enriched by papers that will bear the stamp of the excellence of our instruments upon them, and that the pages of our 'Journal' will have diminishing space for foreign contributions, on account of the value of those from our home market.

In my address last year, I brought before you the subject of the desirability of rendering the microscope available in our natural history and other museums. No one knows better than you that he who sees with his naked eye alone sees but half the world that God has made. With this impression, I suggested the manufacture of a museum microscope on a plan that I find was not at all new, and which has been now at work in the South Kensington Museum for nearly twelve months. It has so far answered its purpose that, whilst thousands have looked at the objects to be seen by its aid, the instrument has not suffered in its arrangements; and the Committee of Council on Education have ordered four of them to be placed in various parts of the Animal Product and Food collections at the South Kensington Museum, for the exhibition of objects which cannot be seen by the naked eye. The only way to gain for society the full advantages of science is to bring the popular mind, by education, into a condition in which it can comprehend the principles involved in the application of its truths in the manifold directions of art, industry, and health. The discoveries of science lose the higher part of their value, unless they become appreciated and applied by an educated public. It is for

societies like ours to encourage the extension of scientific education, to enlist the neophyte in our ranks, and thus to secure accomplished observers and discoverers, and a public capable of comprehending and applying their discoveries.

I have thus endeavoured to glance at the work of the year, and embody the thoughts it suggests; but before I close, I would remind you of the obligation we are under to the Council of the noble Institution within whose walls we have permission to meet. When obliged to leave our apartments in Regent Street, at the latter end of our last session, we obtained the consent of the Council of the Royal Society, and the Senate of the University of London, to meet in the large room which they now jointly occupy. We had hoped that this permission would have been permanent, and I feel it due to the Senate of the London University to say that, as far as they were concerned, such permission was granted; but the Council of the Royal Society could not see its way clear to give up its rooms for our use once a month; and thus we were compelled to look for a meeting-room in some other direction. It was then suggested by Dr. Lionel Beale that application should be made to the Council for permission to meet in the rooms of King's College; and I can bear testimony to the promptitude with which this request was responded to, and you yourselves are the witnesses of the readiness with which all the accommodation we require has been accorded to us. I am also able to state that the Council of this College has, with the same generosity, placed the whole suite of rooms at the disposal of the Society for a soirée on the 11th of April next.

It now remains for me to offer thanks for the courtesy that I have received on all hands, and for the kind manner in which I have been assisted by the Council, and supported by you, in performing the duties of your President. It gives me great pleasure to resign this chair to one who is so well entitled to fill it, and whose election is so honorable to the Society itself. Professor Quekett has worked with us from the beginning, and much of the success of the Society has depended upon his exertions. Many of the most valuable papers in our 'Transactions' are the result of his pains-taking and accurate habits of observation, and he has been our Secretary for nineteen years. These labours alone would have entitled him, at your hands, to the position in which you have this day placed him. But independent of what he has done for you, as Professor of Histology in the Royal College of Surgeons of England, as the author of the masterly lectures which he has delivered from the chair he holds, and as the

first and ablest historian of the microscope, its structure and uses, he has pre-eminent claims to be the President of the Microscopical Society of London. To this post he would long ago have been elected, had your wishes alone been consulted; but his devotion to science has entailed upon him one of its too frequent accompaniments, and that is ill health; and this alone is the plea that he has put in against your wish to make him your President on this occasion. I am sure you will join me in wishing that he may be speedily restored to good health and strength, and that he may never be deterred from occupying your Presidential chair by the presence of those bodily infirmities which accompany disease.

The Society then proceeded to ballot for officers and four members of Council in the usual manner, when the scrutineers having made their report, the following were declared duly elected:

President—Professor QUEKETT. *Treasurer*—N. B. WARD, Esq. *Secretaries*—G. E. BLENKINS, Esq.; M. S. LEGG, Esq.

Four Members of Council—Dr. MILLAR; J. R. MUMMERY, Esq.; Dr. WALLICH; S. C. WHITBREAD, Esq.;—in the place of A. BRADY, Esq.; J. GLAISHER, Esq.; H. PERIGAL, Jun., Esq.; J. H. ROBERTS, Esq.; who retire in accordance with the regulations of the Society.

The thanks of the meeting were unanimously voted to Dr. Lankester, for his services as President during the past two years.

On the AMŒBOID CONDITIONS *of* VOLVOX GLOBATOR.

By J. BRAXTON HICKS, M.D., Lond. F.L.S., &c.

(Read March 14th, 1860.)

THE effect of the attention paid of late to the histology of the lower tribes both of the animal and the vegetable kingdom has been to lessen the number not only of species, but of whole groups, and to rob zoology of many of its subjects. Perhaps this is best shown in the case of the zoospores,

where whole genera of Monadina, Astasiæa, &c., have been distinctly proved to represent only one of the many phases of the respective Algæ to which they belong. But that *Amœba*—the moving and all-devouring "sarcode"—and *Actinophrys* with its extemporised tentacles, possessing some of the very essentials of animal life, should belong to the vegetable kingdom was scarcely to be expected.

Still we have now on record the results of the careful observations of *three* naturalists, which seem to prove that an Amœboid phase occurs in the life of many vegetables.

Dr. Hartig* has noticed that the antheridia of *Characeæ*, *Polytrichum*, and *Marchantia*, change into *Spirillum*, *Vibriones*, and *Monas* consecutively; and that from the fusion together of a number of these last, bodies are formed undistinguishable from *Amœba princeps*. He remarks that, by some means or other, Diatomaceæ find their way into the interior of this self-moving mass, within which they circulate in obedience to the various currents.

Mr. Carter† has watched the changes in the protoplasmic contents of the cells in *Spirogyra*, both conjugating and agamic, from which rhizopodous bodies are produced, some like *Amœbæ*, others becoming precisely similar, in appearance at least, to *Actinophrys sol.*

Dr. De Bary, as noticed in the Journal (vol. viii, p. 97), has lately remarked, in his examination of the Myxogastres, that the creeping threads of mucilaginous matter, by the confluence of which the fructifying mass of *Æthalium* is formed, consist of *Sarcode*. He also remarks, that the spores placed in water burst, and their contents escape, clothed only by a very thin primordial utricle, and furnished with cilia. These bodies progress as ordinary zoospores, and by further changes are converted into organisms precisely like *Amœbæ*, from which, eventually, spore-cases are formed. De Bary, therefore, concludes that the Myxogastres are not fungi, but animals (allied to Rhizopods), and calls them "MYCETOZOA."

A *fourth instance* of this phenomenon occurred to myself in the course of some observations on *Volvox*, six years since, at the end of the summer, at the time when *Volvox globator* was changing into *V. aureus;* although the appearances I allude to were noticed in *V. globator*, in its ordinary form, and in *two* stages of its existence.

The *first* example in which I observed motion in the cell was

* See 'Journ. of Micros. Science,' 1856, p. 51.

† See 'Annals of Nat. Hist.,' 1857, p. 259.

at an early period, before the young *Volvox* is fully grown, at the time when the future zoospores first appear, enclosed in cells, the final product of segmentation. These zoospore-containing cells, by contact with their neighbours, are rendered multangular, and they include about twenty or thirty hexagonal, young zoospores, in close contact, and which are of many colours, as shown at Pl. VI, fig. 12, *a*, *b*. When these cells are detached, they become round, and, (to quote my notes at the time, "They have a curious power of changing shape, like an infusorial *Proteus*, protruding the wall, first at one side, and then at another, into which protrusions the contents run" (fig. 12 *c*). The other and more striking instance, however, was visible in the zoospores themselves at an advanced age, when some of them enlarge and become irregular in outline (Fig. 13 *a*). Some disappear. Some break up and disperse within the *Volvox* (sperm-cells?). Some undergo a process of subdivision (germ-cells?), producing a group of from two to forty green drops, arranged so that their apices, with cilia, point externally; while others enlarge to two or three times their natural size, having many nuclei within, and variously coloured. When this cell, probably by the solution of the outer mucilaginous coat, becomes free, it also possesses the power of moving precisely as does a true *Amœba*. Unfortunately, I did not extend my observations so far as to see if in its progress it included foreign matter,—a point of much interest; the conditions, however, above described were so distinct, that there was no possibility of mistake by confusion with other structures, as I watched these aged zoospores move away in many instances from their original position, while it underwent the transition.

To conclude, with Dr. De Bary, that the Myxogastres are animals, because in some phase of their existence they possess a self-moving endoplast, seems in our present knowledge to be premature; for then must we include the above-mentioned genera, not excepting *Volvox* and its congeners in the animal kingdom,—a step for which botanists are not as yet prepared. A much better explanation seems to me to be this: that the protoplasmic contents, when deprived of their confining envelope of cellulose, possess, in common with Sarcode, under certain circumstances, a power of spontaneous motion in the manner of an *Amœba*. It is questionable how far such actions in the Rhizopodan class are the result of any true consciousness, or whether it is not an involuntary action—a property which can scarcely be denied to vegetables composed only of endo- or protoplast; and this would seem to be strengthened by the fact I have observed, viz., that before protrusion, in the *Amœba*

and Amœboid bodies, takes place, a rush of the semi-fluid contents to the spot can be plainly seen before any bulging occurs. Whether these Amœboid bodies possess the power of "eating," will be a question for future observation.

The above remarks increase the interest connected with the life-history of *Volvox globator*, which from analogy we may suppose to be a zoospore-state of another existence; to which opinion, indeed, the results of investigations are gradually drawing us.

A Monograph of the Genus ASTEROLAMPRA, *including* ASTEROMPHALUS *and* SPATANGIDIUM. By R. K. GREVILLE, LL.D., F.R.S.E., &c.

(Communicated by F. C. S. Roper, Esq., F.L.S., &c. Read March 14th, 1860.)

SINCE the publication of my paper on Diatomaceæ occurring in Californian guano ('Mic. Journ.' vol. vii), some very interesting materials have been placed in my hands, the careful study of which has led me to take a different view than I formerly entertained, of the generic relations of *Asterolampra, Asteromphalus,* and *Spatangidium.* The materials referred to consist of—1. Soundings from the Indian Ocean, obtained by Captain Pullen, in latitude 5° 37′ south, and longitude 61° 33′ east, at a depth of 2200 fathoms. This most remarkable gathering was presented by Mr. Hilton to Mr. Roper, who very kindly transmitted a portion of it to myself. 2. A series of slides prepared from some of the deposits of the United States, by Mr. E. W. Dallas. 3. A series of slides prepared by Professor Walker-Arnott, from the substance known under the name of Monterey stone.

My investigations into the great variety of allied forms derived from these sources point very decidedly towards a union of the three genera above mentioned; and that *Asteromphalus* and *Spatangidium* will most naturally take their place as sections under *Asterolampra.* I may here candidly admit that, soon after the publication of my former paper, I became convinced that I had committed an error in adopting, under any modification, the genus *Spatangidium;* an error which might be traced to my desire to retain, if possible, a genus established by so distinguished a naturalist as De Brébisson. For although at first sight, under a moderate power of the microscope, the difference was so striking as to

justify De Brébisson in using the terms celluloso-reticulate, subpunctulate, subgranulate, &c., in order to describe the relative appearance of the segments under the same magnifying power, it was easy to see by sufficiently increasing the power that the structure of all was essentially the same.

In the preparation of the present communication, I gladly acknowledge the valuable suggestions I have received from my friends, Professor Walker-Arnott and Mr. Roper.

As some confusion already exists with regard to the names applicable to the different parts of these discs, it is desirable that some attempt should be made to regulate them. I venture, therefore, to propose the following nomenclature, which will be followed in this paper, and easily understood with the help of the following diagram:

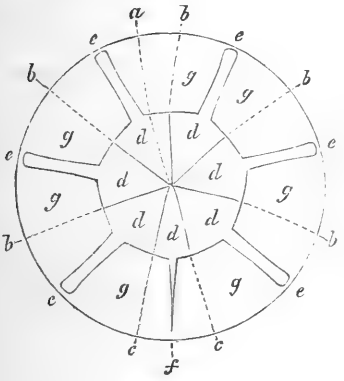

Fig. 1.

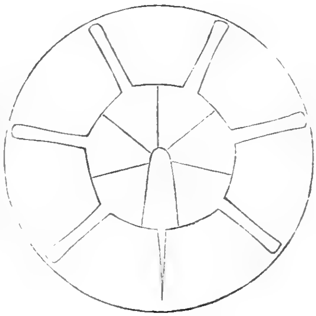

Fig. 2.

Fig. 1, diagram of *Asteromphalus*; Fig. 2, diagram of *Spatangidium*. To convert Fig. 1 into a diagram of *Asterolampra*, all that is required is to separate the lines *cc* a little, and make the ray *f* as broad as the rest.

a umbilicus, *b* umbilical lines, *c* median lines (approximated umbilical lines), *d* hyaline area (composed of the united bases of all the rays), *e* rays, *f* median ray, *g* areolated segments.

A few explanatory remarks may be required with reference to some of these terms. It has been suggested that "hyaline area" is uncalled for, because it is composed merely of the bases of the rays. This is true, but it is composed of the bases of the rays *collectively*, and it will be very convenient sometimes to be able to define the contour, position, &c., of this area. As to the rays themselves, there can be no doubt

that it is desirable to restrict the appellation to those radiating divisions which, commencing at the umbilicus, are at first included between the umbilical lines and are afterwards continued in a contracted and linear form between the areolated segments to the margin. The umbilical lines ("sepimenta imperfecta," of Ehrenberg) offer greater facilities for description than the bases of the rays themselves, and a name for them could hardly be dispensed with.

Several terms have been suggested for the narrow or "obsolete" ray which occurs in *Asteromphalus* and *Spatangidium;* but, upon the whole, I prefer that of "median," which is as expressive as any of the others, and has the advantage of having been already used by De Brébisson. An additional recommendation is, that it enables me to apply the equally expressive term, "median lines," to the two approximated lines above the median ray, there being evidently some connection between these parts. The position of these lines differs in *Asteromphalus* and *Spatangidium.* In the former genus they appear as really umbilical lines, approximated indeed, but still springing, like the rest, from the central point. In the latter they do not do so, and therefore cannot strictly be called umbilical lines. In fact, they have no relation with the other lines in point of radiation. It was, therefore, desirable to invent a term which should be equally applicable in both genera. By the term median, then, I wish to imply the two lines which invariably accompany the median ray, and only exist in connection with it. We shall see that much interest attaches to these lines, and that they afford good discriminative characters.

Without giving the original characters *verbatim,* the three genera under consideration are distinguished as follows:

ASTEROLAMPRA, Ehrenb. in 'Berl. Monatsbericht,' 1844, p. 73. The valve is strictly circular, with a centrical hyaline area, which is equally divided by lines ("sepimenta") radiating from the umbilicus. Each of these lines terminates at the base of a marginal areolated segment, while alternating with them the rays are continued between the segments to the margin.

ASTEROMPHALUS, Ehrenb. in 'Berl. Monatsbericht,' 1844, p. 198. The valve is exactly circular, with a centrical hyaline area; but, instead of being equally divided by the lines ("sepimenta imperfecta") which radiate from the umbilicus, two of them are approximate and parallel; and instead of all the rays being equal, one of them is much narrower than the rest, or, as Ehrenberg calls it, "deficiens vel ita obsoletus."

SPATANGIDIUM, De Bréb. 'Bull. de la Soc. Linn. de Nor-

mandie,' 1857. The valve is "suborbicular," and the "point d'où rayonnent les ambulacres . . . . est toujours excentrique."

It will be perceived that if we take a frustule of *Asterolampra* (which may be assumed as the typical form of the group), and merely approximate two of the umbilical lines, so as to become parallel, and make the ray between them narrower than the rest, we have at once an *Asteromphalus*; and that between the latter genus and *Spatangidium* there is only (according to De Brébisson's view) the eccentrical position of the hyaline area, with its lines and rays. Again, if we take the genus *Asterolampra* as our stand-point, and examine in what respects Ehrenberg has made *Asteromphalus* to differ from it, we are reduced to the conclusion that the former rests its claim to generic distinction, as compared with the latter, on the sole circumstance that the rays and umbilical lines are all equal.

Let us now examine how far these genera have been affected by recent discoveries. In *Asterolampra* the species named *Marylandica* was the only one known to Ehrenberg; and though various others have been subsequently described, they must all be referred to that species. In all of them the areolated segments are concave at the base, and the umbilical lines straight and simple. But other species, very different in habit, must now be introduced on the claim specified in the close of the last paragraph. One of these is *Asteromphalus Grevillii*, of Wallich,* from the Indian Ocean, found also by Mr. Dallas in the Rappahannock deposit, United States, and by Professor Walker-Arnott in Monterey stone; in which the numerous segments are square at the base, and the umbilical lines are variously divided. In *A. variabilis*, another species found in the same material, the umbilical lines are most of them divided near to the central point, being either forked or arranged in triplets; while the base of the segments is so sharply angular as to give a triangular aspect to the adjoining portion of the rays.

In a third species from the same source (*A. Brébissoniana*, Pl. III, fig. 9), the numerous segments are square at the base, and the umbilical lines exhibit the angular bend in the middle, which is observable in certain species both of *Asteromphalus* and *Spatangidium*. It is impossible not to perceive how strongly the characters and natural habit of the diatoms noticed above run into those of the last-named genera.

Asteromphalus, as we have already seen, only differs (ac-

* 'Trans. Mic. Soc.,' vol. viii, p. 47, Pl. 2, fig. 15.

cording to Ehrenberg himself) from *Asterolampra* in two of the umbilical lines common to both genera becoming approximate and "parallel," and in one of the rays common to both genera becoming narrower than the rest. But even this difference is not strictly maintained in all Ehrenberg's own species; for in *A. Darwinii* and *A. Rossii* the median lines are not "parallel," but cuneate. This deviation from the generic character is still more prominent in recently discovered species, which, notwithstanding, cannot be excluded from this place. In my *Asterolampra Dallasiana,* for example (Pl. IV, fig. 10), the median lines are campanulate; and in my *Asterolampra Wallichiana* (fig. 11), they are so widely cuneate as to show a decided approach to *Asterolampra* as restricted by Ehrenberg. It is evident, therefore, that were the genus to be sustained, the character derived from the parallelism of these lines would have to be abandoned. With regard to the form of the segments, they are represented as concave at the base in all Ehrenberg's species. In *Asterolampra Dallasiana* and *A. Wallichiana,* however, they are square at the base. The angular bend in the umbilical lines which marks some species of *Asterolampra* and *Spatangidium* is found also in *Asteromphalus* in one or two instances.

I have remarked elsewhere—and am glad to see that my view is supported by Dr. Wallich—that the character on which De Brébisson founded his genus *Spatangidium,* viz., the eccentrical position of the hyaline area, is far too uncertain to be relied on; for valves are continually occurring in which this feature is scarcely, if at all, perceptible. And when this character disappears, so also does the "sub-orbicular" form of the valve. How little dependence can be placed upon it is well shown in *S. heptactis* of De Brébisson (*S. Ralfsianum* of Norman, in my former paper). De Brébisson does not state the form in his description, but his figure represents it as broadly ovate, whereas in mine it is the very reverse.* An exception, however, appears to exist in *Spatangidium Arachne,* which, as far as I have observed, retains constantly its round-ovate outline, as well as its highly eccentrical arrangement. A better generic character than the latter might have been found for *Spatangidium,* as Professor Walker-Arnott has suggested, in the median lines (Dr. Wallich's basal ray) passing over and beyond the central point, so as to cause the umbilical lines to radiate from the top and sides of the median lines, and not from the central point

* 'Mic. Journ.,' vol. vii, Pl. 7, fig. 8.

itself, as in *Asteromphalus*. A most remarkable species, however, belonging to the Indian Ocean soundings—my *Asterolampra Roperiana* (Pl. IV, fig. 14)—seems to form a connecting link, not only between these two genera, but including the *Asterolampra* of Ehrenberg itself. It will be seen at a glance that the plan, so to speak, of the valve is far more that of *Asteromphalus* than of *Spatangidium*. In the circular outline, in the centrical hyaline area, radiation of the umbilical lines, approximation of the median lines, and in the median ray, it is an *Asteromphalus*. In the single circumstance that the median lines pass slightly beyond the central point, forming a little imperfect circle round it, is the frustule, a *Spatangidium*. The median lines in this species present some additional curious features. But for the intervention of the little imperfect circle, which may be compared to the nave of a wheel, the umbilical lines would meet at precisely the central point. Immediately beneath the imperfect circle the median lines contract into a sort of neck, and then, instead of continuing to be approximate, as they ought to do for a *Spatangidium*, or parallel, as Ehrenberg would require of them for an *Asteromphalus*, they diverge, and by a curve reach the edge of the hyaline area at points almost equidistant between themselves and from the adjoining umbilical lines. In this last character (sub-equidistance of the *termination* of the median lines), as well as in the sub-equidistance of all the rays, the median one included, the frustule is very nearly an *Asterolampra*. The valve in my *Asterolampra Shadboltii* is also circular, and, but for the median lines passing slightly beyond the central point, would in every other respect belong to the *Asteromphalus* section. In *Asteromphalus Brookei*, likewise, of the late Professor Bailey, the valve, if not actually circular, appears to be so to the eye, and the median lines, which somewhat resemble those of *Asterolampra Roperiana*, scarcely pass beyond the central point. Enough has been said, perhaps, to illustrate the transition of these genera into each other; and we may now proceed, in accordance with the views advocated, to give a systematic arrangement of the known species.

ASTEROLAMPRA, *Ehrenb.*

ASTEROMPHALUS, Ehr. SPATANGIDIUM, De Bréb.

Frustules simple, two-valved, disciform. Valves orbicular or sub-orbicular (in one case oblong); central area hyaline, and furnished with radiating lines, each of which terminates at the base of an areolated marginal segment; while, alter-

nating with them, transparent rays are continued from the hyaline area between the segments to the margin.

SECTION I.—Rays equal and equidistant: ASTEROLAMPRA.

1. *Asterolampra Marylandica*, Ehr. Umbilical lines simple, straight; areolated segments curved at the base. Diameter ·0016″ to ·0080″. (Pl. III, figs. 1—4.)

Asterolampra Marylandica, Ehr. Berl. Monatsbericht, 1844, p. 76, Pl. (June), fig. 10. Bail. Sill. Journ., vol. xlviii, Pl. 4, fig. B. Kutz. Sp. Alg., p. 129. Pritch. Animalc., p. 320, Pl. 14, fig. 33. Mic. Dict., p. 71, Pl. 19, fig. 5. Wall. Trans. Mic. Soc., vol. viii, p. 47, Pl. 2, figs. 13 (6 rays), 14 (7 rays). Brightw. Mic. Journ., vol. viii, Pl. 5, fig. 3 (6 rays).
A. septenaria, A. S. Johns. Sill. Journ., 2d ser., vol. xiii, p. 33.
A. impar, Shadb. Trans. Mic. Soc., vol. ii, Pl. 1, fig. 14 (7 rays).
A. pelagica, Ehr. Berl. Monatsbericht (1854), p. 238. (Noticed first by Müller, Abhandl. d. Berl. Akad. 1841, vol. i, p. 232, Pl. 6, fig. 4, in his Memoir über den Bau des Pentacrinus caput Medusæ (7 rays).

Hab. Various deposits in the United States (6 to 9 rays). West Indies (7 rays), R. K. G. Natal (7 and 11 rays), Shadbolt. Monterey stone (7 rays), Professor Walker-Arnott. Indian Ocean, from *Salpæ* (6 and 7 rays), Wallich. Indian Ocean soundings, at 2200 fathoms (6 rays).

This species is exceedingly variable; and, notwithstanding the number of figures which have been given of it, several of which, however, are merely repetitions of each other, I have considered it very desirable to offer some additional ones, in order more fully to illustrate deviations from what may be regarded as the typical form, well represented by Ehrenberg's original figure. That author has assumed eight as the normal number of the rays, and he is probably correct with reference to the frustules found in the American deposits. I believe that number to predominate, although specimens with from six to nine rays also occur in the same deposits. It is at the same time a very curious fact, that in the Indian Ocean soundings every example which has come under my notice possesses only six rays; and Dr. Wallich has represented one, likewise with that number, obtained from *Salpæ* in the Bay of Bengal. While thus the number eight appears to predominate in the American deposits, and six in the Indian Ocean (so far as known), an odd number, seven or eleven, was found by Mr. Shadbolt to exist exclusively in a gathering from Port Natal. It would be rash from such limited data to conclude that these are the prevailing numbers on the coast of East Africa; still it is remarkable, that in the gathering specified,

with the frustules "moderately abundant," not one should have been observed having other than seven or eleven rays. The extreme range appears to be from six to twelve; Dr. Wallich refers to one in his possession, without mentioning the locality, containing the latter extraordinary number. It is, however, now admitted on all hands that the number of rays is of no diagnostic value whatever; and, consequently, it is necessary to bring together all those so-called species which have no other character to rest upon. Among the examples which I have given in Plate III, are frustules with six, seven, and nine rays; but I have not selected these forms on account of this variation, but in order to show how widely the valves may otherwise differ, and to assist in determining the question of identity. In fig. 1, from Piscataway, Maryland, the rays are not only numerous, but the segments form an extremely deep curve; and in Dr. Wallich's figure, 14, l. c., the same effect is produced with fewer rays, in consequence of the segments being carried still nearer to the umbilicus. In my figure 3, detected by Mr. Dallas in "Bermuda Tripoli," the species seems to have reached the very opposite extreme, and its most aberrant condition. The hyaline area is so large as to occupy half the radius; and the curve of the areolated segments is not only very shallow, but ceases to be regular, being considerably flattened; all which makes the rays appear so short, that they might be compared to the handles of a steering-wheel. I have introduced figure 2, from Rappahannock, to show that while the hyaline area occupies even a larger portion of the valve than the preceding, the segments preserve the true curve. The valve has seven rays, and presents a most striking contrast to Dr. Wallich's fig. 14, l. c. My fig. 4 represents a frustule from the Indian Ocean soundings, remarkable for its gigantic size. It exhibits also a peculiarity, observable in all the specimens, obtained from the same quarter,—a greater breadth of the ray than usual. The umbilical lines may be said to be normally simple in this species; but one or two of them are occasionally forked close to the central point, as seen in fig. 1.

With regard to the nature of these lines, it is improbable that they indicate an actual division or dissepiment between the bases of the rays, as such a provision would seem to be useless while the remaining portion of those organs is so firmly united to the adjoining parts. In the numerous fractured specimens of *Asterolampra* and *Spatangidium* I have examined, I have never been able to trace any disposition in the valve to break up in the direction of these lines. The more correct view, it appears to me, is that suggested by Mr.

Roper, viz., that they are raised and thickened lines, intended to strengthen the valve. In a frustule of *A. Marylandica,* to which he drew my attention as throwing some light on the subject, a portion of the hyaline area has been accidentally destroyed, leaving one of the lines denuded throughout its whole length. From its evident strength, it is admirably adapted to the purpose assigned to it by Mr. Roper. Indeed, the hyaline area, in all these diatoms, may not be unaptly compared to a circular window, with radiating bars, fitted with transparent siliceous panes. In several species of this and the following sections, there is an apparent thickening in the rays, especially where they pass the confines of the hyaline area. At this part there is sometimes a sort of ridge or convexity, which gradually subsides into the plane surface of the basal portion of the ray. This appearance is indicated in Mr. Shadbolt's figure already quoted, and is probably caused by an internal channel, the termination of which, near the umbilicus, is occasionally tolerably evident; but I do not find anything like the line passing down the *middle* of the ray, as faintly seen in Mr. Shadbolt's figure, and conspicuously in that given by Mr. Brightwell. ('Mic. Journ.,' vol. viii, pl. 5, fig. 3.) That the rays are tubular, seems to be confirmed by Dr. Wallich, who finds air-bubbles in them in some of his balsam-mounted slides. It is now well known, that the two valves of the frustules of this group do not correspond in the disposition of the rays, or, to use a printer's phrase, they do not register; but that the ray of one valve is opposite to the areolated segment of the other,—a circumstance which, to an inexperienced observer, is often not a little perplexing. This arrangement was first noticed by Müller, who, in fact, figured the two valves of *Asterolampra* in their normal position, before Ehrenberg himself constituted the genus. He remarks, "Dieser Stern ist eine Doppelfigur und besteht aus einem vordern und hintern stern, woven jeder 7 Strahlenhat, die Strahlen des hinteren stehen in den Zwischenräumen der Strahlen des vorderen."*

It is a curious fact, that in species where the umbilical lines are more or less branched, those of the two valves do not necessarily correspond. In a beautiful frustule in my possession, of *Asteromphalus Brookei* of Bailey, the upper valve is so convex that the umbilical lines can be focused distinctly from those of the lower flat valve, and it appears that the furcation of the two sets of lines is to some extent different. This tends to confirm Mr. Roper's idea above-

* Abhandl. d. Berl. Akad. (1841), vol. i, p. 232.

mentioned, that these lines are to be considered mainly as ribs or bars of support. No species has so wide a range with regard to size as *A. Marylandica.* The smallest that has come under my notice is a specimen belonging to Mr. Roper, of Shadbolt's *A. impar,* which is only ·0018″.

2. *Asterolampra Rotula,* n. sp. Grev.—Areolated segments nearly square at the base; umbilical lines simple, or forked close to the central point. Diameter ·0044″. (Pl. III, fig. 5.)

Hab.—Monterey stone, Professor Walker-Arnott.

It is with considerable hesitation that I venture to offer this diatom as distinct from the following, and should not have done so but for the opportunity afforded me by Professor Walker-Arnott, of inspecting a series of that species. I find, on a close examination, and after making drawings of a number of specimens, so uniform an adherence to the character furnished by the base of the segments, that I cannot at present bring myself to regard the present form as a variety. At the same time it may be held as only provisionally independent. The segments are somewhat square at the base, and the linear portion of the rays commences abruptly at the margin of the hyaline area; whereas, in the following species, the linear portion of the rays assumes a triangular figure before leaving the hyaline area, in consequence of the very different outline of the base of the segments. The umbilical lines of the two are much alike; those of the species under consideration showing a disposition to divide. It will be perceived that one of them, immediately after leaving the central point, separates into three branches.

3. *Asterolampra variabilis,* n. sp. Grev.—Areolated segments, with a dipping angle at the base; upper part of the basal portion of the ray triangular; umbilical lines simple, forked, or in triplets. Diameter ·0028″ to ·0048″ (Pl. III, figs. 6—8.)

Hab.—Monterey stone, Professor Walker-Arnott.

The most characteristic feature, as I conceive, of this diatom, arising from the form of the basal portion of the rays, and consequent angular base of the segments, has been referred to in my remarks on the preceding species. The result of this character is a very beautiful rosette-like contour of the hyaline area, and constant in all the specimens I have seen. The umbilical lines, also, are remarkable. In *A. Marylandica* they are, as we have seen, normally simple, being rarely (one or two only) forked. In the species now before us, the reverse is the case. In the great majority of instances the lines are forked or in threes; so that in the same valve there will seldom be more than two of them un-

divided. In the series already referred to, as communicated by Professor Walker-Arnott, the following arrangements of these lines occur. (1.) In a valve with seven rays, one line is simple, six united in triplets; so that only three lines actually radiate from the central point. (2.) A valve of eight rays (fig. 6): two simple lines and two triplets; four lines therefore radiate from the central point. (3.) Another valve with eight rays: one simple line, two forked and one triplet; four lines, as before, radiating from the centre, but by a different combination. (4.) A valve with nine rays (fig. 7): two simple lines, two forked and one triplet; in this case the divisions occur at a considerable distance from the umbilicus, and five lines emanate from the central point. (5.) A valve with ten rays: no simple line at all, but two forked and two triplets; only four actually radiating from the centre. (6.) A valve with eleven rays (fig. 8): one simple line, two triplets, and one quadruplet; still only four proceeding directly from the umbilical point. It will be obvious from the above statement, that there is a decided tendency in the umbilical lines of this species to arrange themselves in triplets. I regret that I have not space to admit of the entire series being engraved, but the examples I have selected will afford a good idea of the whole. It is worthy of observation that the valve I have represented at figure 6 seems, on a momentary glance, to possess what I have called median lines, which enclose Dr. Wallich's "basal ray" ("from the true rays being always arranged around or upon it"); but this is a deception. Median lines, according to my view, cannot exist apart from a median ray, and consequently are not to be found in this section of the genus. In the present instance it will be perceived, by a comparison with figures 7 and 8, that the appearance is caused by two triplets of umbilical lines happening to adjoin each other. The same effect is twice repeated in figure 8, only not quite so conspicuously. Dr. Wallich proposes to substitute the term "basal" ray for median or "obsolete" ray;* but as there is no instance on record of more than one median ray occurring in the same valve, he must use the term in a more enlarged sense in his highly interesting paper, when he ascribes three basal rays to the species he has done me the honour to associate with my name. In one of Professor Walker-Arnott's slides is an abnormal valve of *A. variabilis* with the hyaline area very eccentrical, and the whole having exactly the appearance as if it had been intended for a

* 'Trans. Mic. Soc.,' vol. viii, p. 45.

Spatangidum. It has six rays, the lower one much the longest; the upper one short, and the lateral ones slightly curved downwards. This accidental deviation from the ordinary arrangement of the valve in this species is immaterial, except as an additional illustration of the tendency in individuals belonging to the different sections of the group to partially assume the general appearance of each other.

4. *Asterolampra Grevillii.*—Areolated segments square at the base; rays numerous; umbilical lines divided and arranged in parcels or groups of from two to five lines each. Diameter about ·0034″. (Pl. IV, fig. 21, an abnormal valve.)

Asteromphalus Grevillii, Wall. Trans. Mic. Soc., vol. viii, p. 47, Pl. 2, fig. 15.

Hab.—Rappahannock Deposit, United States, Mr. E. W. Dallas. Indian Ocean, Dr. Wallich. Monterey stone, Professor Walker-Arnott.

The uniform character of the rays brings this species into the present section. The examples originally discovered by Mr. Dallas, and which I had described in MS. as unquestionably distinct, I have little or no hesitation in now referring to this place. Although no character can be strictly drawn from the number of rays, yet it would seem that in this diatom they are so numerous as to give it a peculiar appearance. The umbilical lines, as they radiate from the central point, are very few; but they almost immediately divide in such a way, that a group of lines seems to be supported, as it were, by a single short stalk. The frustule figured by Dr. Wallich has thirteen rays; the umbilical lines are combined into three groups; the three little stalks which support them alone radiating from the central point. One of the American specimens, of which I had prepared a drawing, contains fifteen rays; and the umbilical lines are combined into four groups, supported by as many little stalks. Another of the American specimens contains seventeen rays. The one with fifteen rays has four, which Dr. Wallich would call "basal;" that is, they unite at the umbilicus exactly in the same manner as do his three "basal rays" in his figure of the present species. Consequently, if I am right in considering the American and Indian individuals as identical, the species might be said to possess an indefinite number of such rays. But, as I have already remarked, this arrangement of the rays admits of a different and more satisfactory explanation. At figure 21 (Pl. IV), I have introduced a valve, from the

Indian soundings, having a very irregular and curious arrangement of the umbilical lines.

5. *Asterolampra Brébissoniana,* n. sp. Grev.—Areolated segments square at the base; umbilical lines with an angular bend in the middle. Diameter ·0030′. (Pl. III, fig. 9.)

Hab.—Monterey stone, Professor Walker-Arnott.

This may be regarded as one of Professor Walker-Arnott's most interesting discoveries, as it shows that the very remarkable angular bend in the umbilical lines, already known to exist in some species of *Asteromphalus* and *Spatangidium,* is not excluded from the present section; and therefore strengthens, in however small a degree, the argument in favour of the union of the whole group into one genus. I have much pleasure in dedicating so well-marked a species to M. Alphonse de Brébisson, whose name is so eminently associated with these wonderful structures.

SECTION II.—Rays unequal (one much narrower than the rest). Umbilical lines radiating from the central point; two of them approximated.—ASTEROMPHALUS.

6. *Asterolampra Hookerii.*—Areolated segments curved at the base; umbilical lines straight, the two approximated ones (median lines) parallel.

Asteromphalus Hookerii, Ehr., Berl. Monatsb., 1844, p. 200, pl. (June), fig. 3; Kütz., Sp. Alg., p. 129; Pritch., Animalc., p. 321; Mic. Dict., p. 71, pl. xix., fig. 2; Ehr., Mikrogeol., pl. 35, A. xxi., fig. 2 (6 rays).

Asteromphalus Buchii, Ehr., Berl. Monatsb., 1844, p. 200, fig. 4; Kütz., l. c., p. 130; Pritch., l. c., p. 321; Mic. Dict., p. 71 (7 rays).

Asteromphalus Humboldtii, Ehr., Berl. Monatsb., 1844, p. 200, fig. 6; Kütz., l. c., p. 130; Pritch., l. c., p. 321, pl. xiv., fig. 34; Mic. Dict., p. 71; Ehr., Mikrogeol., pl. xxxv., A. xxi., fig. 3 (8 rays).

Asteromphalus Cuvierii, Ehr., Berl. Monatsb., 1844, p. 200, fig. 7; Kütz., l. c., p. 130; Pritch., l. c., p. 321; Mic. Dict., p. 71; Ehr. Mikrogeol., pl. 35, A. xxi., fig. 1 (9 rays).

Hab.—The Antartic Ocean, Dr. J. D. Hooker.

As the celebrated Ehrenberg regarded a simple difference in the number of rays as amounting to specific distinction, he has added a multitude of names to our list of Diatomaceæ which cannot now be permitted to retain their position. Such is pre-eminently the case in the genera *Actinocyclus* and *Actinoptychus,* which will probably be found ultimately to contain comparatively few true species. In *Asteromphalus* the same system was carried out. The four species now brought together are only distinguished by each individual having

one more ray than its predecessor. In every other respect they are precisely similar.

7. *Asterolampra Dallasiana*, n. sp., Grev.—Areolated segments square at the base; umbilical lines straight; median lines campanulate. Diameter ·0038″. (Pl. IV, fig. 10.)

Hab.—In "Bermuda Tripoli," Mr. E. W. Dallas.

The diatomist cannot fail to observe how similar this form is to some of the species described in the first section, with the exception only of the median ray and median lines. In general habit it is widely different from all the *Asteromphali* of Ehrenberg, but agrees more with the following species, also detected by my lynx-eyed friend, Mr. Dallas, in the same material. The precise locality of this famous "Tripoli" was for some time a mystery; but the readers of the 'Microscopical Journal' will be aware that Professor Walker-Arnott believes that he has traced it to a place called Bermuda, about twenty miles below Richmond in Virginia.* Considering that the genera *Heliopelta, Craspedodiscus*, &c., have never been found elsewhere, it may be said to be the most precious deposit known; and the discovery in it of two new species of the present section of *Asterolampra* will add not a little to its interest. It is remarkable, however, that if it really forms a part of the great Richmond deposit, nothing like it should have been found since the original supply passed into circulation.

8. *Asterolampra Wallichiana*, n. sp., Grev.—Areolated segments square at the base; umbilical lines straight, the two median one scuneate. Diameter ·0021″. (Pl. IV, fig. 11.)

Hab.—In "Bermuda Tripoli," Mr. E. W. Dallas.

Only one specimen of this species has been seen, and it is conspicuous for the polygonal aspect of the hyaline area, which resembles the disc of an *Ophiura*. There are only six rays, and the basal portion of each is so wide next the areolated segments, that it may be compared to a short-bladed trowel, while the linear part represents the handle. These relative proportions, however, may not be constant.

9. *Asterolampra Beaumontii.*—Areolated segments curved at the base; umbilical lines with an angular bend; median lines straight, parallel.

Asteromphalus Beaumontii, Ehr., Berl. Monatsb., 1844, p. 200, pl. (June), fig. 5; Kütz., l. c., p. 130; Pritch., l. c., p. 321; Mic. Dict., p. 71, 2d edit., Pl. 43, fig. 15.

Hab.—Antarctic Ocean, Dr. J. D. Hooker.

* 'Mic. Journ.,' vol. vii, p. 254.

A very singular species, having the ordinary umbilical lines furnished with an angular bend in the middle, while the median lines are straight. It thus forms a transition from the previous species of the section to the following one.

10. *Asterolampra Darwinii.*—Areolated segments somewhat square at the base; umbilical lines with an angular bend; median lines cuneate, with an angle midway, furnished with a minute spine-like projection. Diameter ·0019″ to ·0035″. (Pl. IV, figs. 12, 13.)

Asteromphalus Darwinii, Ehr., Berl. Monatsb., 1844, p. 200, pl. (June), fig. 1; Kütz., l. c., p. 129; Pritch., l. c., p. 320; Mic. Dict., p. 71 (5 rays).

Asteromphalus Rossii, Ehr., Berl. Monatsb., 1844, p. 200, pl. (June), fig. 2; Kütz., l. c., p. 130; Pritch., l. c., p. 321; Mic. Dict., p. 71; Ehr., Microgeol., pl. 35, A. xxi, fig. 4 (6 rays).

Hab.—Antarctic Ocean, Dr. J. D. Hooker. Monterey stone, Professor Walker-Arnott.

The determination of this species has been accompanied with a good deal of perplexity. The figures given by Ehrenberg represent the base of all the areolated segments as curved—not in the remotest degree as tending to square; whereas in the specimens obtained by Professor Walker-Arnott from the Monterey stone (all of them four-rayed), the hyaline area is decidedly quadrangular. Nay, more than that, the outline of the hyaline area between the median and adjoining rays is slightly but unequivocally convex instead of concave. It is difficult to conceive how so great an amount of error should have crept into Ehrenberg's figures, if the Monterey specimens be really the same. I confess that I am not quite satisfied on this point, although the umbilical and median lines agree. In deference, however, to Professor Walker-Arnott's opinion, I refer his Monterey valves in the mean time to this place, and offer representations of two examples, in order that the discrepancy between them and Ehrenberg's figures may be better understood. It will be noticed that there is some difference in the median lines in the two valves; but the absence of the angles in figure 13 may be regarded as accidental.

SECTION III.—Rays unequal. Umbilical lines radiating from the top and sides of the median lines; which latter pass beyond and enclose the central point.—SPATANGIDIUM.

* Umbilical lines without an angular bend.

11. *Asterolampra flabellata.*—Areolated segments curved

at the base; umbilical lines all straight, radiating from the apex and sides of the median lines. Diameter ·0017″ to ·0024″.

Spatangidium flabellatum, De Bréb., Bull. Soc. Linn. de Normand., vol. iii, Pl. 3, fig. 3.
Asteromphalus flabellatus, Grev., Mic. Journ., vol. vii, p. 160, Pl. 7, figs. 4, 5.
Spatangidium peltatum, De Bréb., l. c., Pl. 3, fig. 4.

Hab.— Peruvian Guano, De Brébisson. Californian Guano.

After a reconsideration of the claims for distinction put forth on behalf of the two diatoms above quoted, I cannot find any really trustworthy characters to separate them. The slightly arcuate rays in *S. flabellatum* will not alone suffice, as this appearance may be seen occasionally in species whose rays are normally straight; and the "subpinnate" disposition of the rays in *S. peltatum* is rather a deception, arising simply from the number being uneven, and the odd ray being placed on the apex, in the direction of the median lines. Beyond these two characters—the one as uncertain as the other—there is nothing to rest upon. The number of rays in the specimens I have seen is ten or eleven; but a larger series of examples would probably show a wider range. The areolation is very minute.

12. *Asterolampra Hiltoniana,* n. sp. Grev.—Areolated segments acutely curved at the base; umbilical lines radiating from the apex and sides of the median lines, the two lower pair suddenly deflexed. Diameter ·0038″ to ·0052″. (Pl. IV, fig. 15.)

Hab.—Algoa Bay Guano, R.K.G. Indian Ocean soundings, made by Captain Pullen.

On a former occasion, this species was referred to by me as probably distinct;* but at that time I had only seen two examples with ten rays each. In the Indian soundings I have met with numerous individuals (including fractured ones, which are often equally instructive), and my previous impression is fully confirmed. The latter specimens are much finer, the rays varying from fifteen to nineteen. Three of the umbilical lines on each side are generally deflexed, but the lowest two on each side are more or less suddenly bent downwards in the middle, either by a sharp curve or angle. In the African specimens the lines are all simple. So are they all in an Indian valve of eighteen rays. In the Indian one, however, which I have figured, with nineteen rays, three of the lines are forked. It is a very transparent species, and

* 'Mic. Journ.,' vol. vii, p. 160.

easily overlooked. The rays are slender, and the areolation very minute.

* * Umbilical lines with an angular bend.

13. *Asterolampra elegans,* Grev.—Areolated segments sharply curved at the base, more than half the radius; umbilical lines radiating from the apex and sides of the median lines, normally simple, but sometimes once or even twice forked. Diameter ·0030″ to ·0060″. (Fig. 16.)

Asteromphalus elegans, Grev.,'Mic. Journ., vol. vii, p. 7, Pl. 7, fig. 6, Wall. Trans. Mic. Soc., vol. viii, p. 46, Pl. 2, fig. 10 ?

Hab.—Californian Guano. Soundings from the Indian Ocean, in 2200 fathoms, made by Captain Pullen.

My figure formerly published represents a small normal example; but the specimens which occur in the Indian soundings present so extreme a deviation from the typical state, that an additional illustration becomes absolutely necessary. In most of these Indian valves there is a disposition in the umbilical lines to divide, or even subdivide; and this is done so irregularly that simple lines may be mixed with the forked ones. In three specimens now before me, the first, with seventeen rays, has three of the lines forked and one twice-forked. The second, with twenty rays, has four forked and one twice-forked. The third, a magnificent and perfect specimen, with twenty-five rays (fig. 16), has seven lines forked and one twice-forked; so that only five of the lines remain in their normal condition. A large specimen in Mr. Roper's cabinet, of which he has sent me a drawing, exhibits a still more whimsical aberration. It has twenty-nine rays, but only ten umbilical lines radiate directly from the median lines; of these, one is divided into six, another into seven branches. Four lines only are simple. In the sketch of another valve containing twenty-five rays, sent by Mr. Norman, six lines are simple. In these anomalous valves the angular bend becomes less conspicuous, because the ramification generally takes place at one or both angles of the bend; a fact which rather tends to strengthen my remark under *A. heptactis,* that where the angular bend exists, a ramulus however fine, or at least a disposition to originate a ramulus, may be also presumed to exist. The areolation of this species is extremely minute, and the rays are gracefully slender. I have some scruples about referring the valve, which Dr. Wallich has figured, to this place, without an opportunity of tracing its connection. The peculiar-looking median lines, robust rays, and apparently rather large areolation, seem to indicate a difference.

14. *Asterolampra imbricata.*—Areolated segments, sharply curved at the base, less than half the radius; rays numerous, robust; angular bends of the umbilical lines forming unitedly an oblong elliptical figure. Diameter ·0024″ to ·0034″. (Fig. 17.)

Asteromphalus imbricatus, Wall., Trans. Mic. Soc., vol. viii, p. 46, fig. 9.

Hab.—*Salpæ,* Bay of Bengal, Dr. Wallich. Soundings from the Indian Ocean, in 2200 fathoms, made by Captain Pullen. Natal, Mr. Roper.

One of the most distinct and beautiful species I am acquainted with. The appearance of the valve is singularly rich, the usual parts being so arranged as to present successive series of radiations. The umbilical lines are given off from the top and sides of the median lines in such an equal, symmetrical manner that the angular bends are in close and parallel approximation. The oblong-elliptical line thus formed, taken at its widest part, is about a third of the radius, and constitutes what may be called the first zone in the radiation. The continuation of the umbilical lines to the base of the segments, taken along with the enclosed basal portions of the rays, forms a second zone; and the narrower portion of the rays, with the areolated segments, a third zone. As all the specimens which I have examined differ somewhat from Dr. Wallich's figure, I have thought it desirable to give a supplementary one, of a valve with twenty-one rays. I have another drawing of an equally perfect valve, with seventeen rays, in all respects similar. In my valves the median lines taper down beautifully to the median ray, and exhibit an abortive angular bend at the proper place. The most material difference, however, between Dr. Wallich's figure and my specimens consists in the wide space represented by him between the two lowest rays and the median ray; whereas in my extensive series of valves there is no greater space than there is between any of the other rays; indeed, in most frustules, the space is rather less. The outline of the valve is slightly, but perceptibly, ovate; the areolation considerably larger than in *A. elegans,* its nearest ally. It is the most robust species which has occurred in the Indian soundings, and hence, perfect individuals are not quite so rare as in other cases. Among Mr. Roper's drawings is one of a valve from Natal, with only ten rays, and in diameter only ·0015″. In all material characters, however, it agrees well with the present species.

15. *Asterolampra Brookei.*—Valve nearly quite circular;

areolated segments nearly square at the base; angular bend of the umbilical lines situated towards the outer extremity; median lines scarcely passing beyond the central point, arched at the top, then contracted, afterwards more or less divergent. Diameter ·0028″ to ·0036″. (Fig. 18.)

Asteromphalus Brookei, Bail., Sill. Journ., 2d ser., vol. xxii, p. 2, Pl. 1, fig. 1.

Hab.—Sea of Kamtschatka, in soundings made by Lieut. Brooke, in 1700 fathoms, Professor Bailey. Atlantic soundings, Mr. Roper.

Were it not that I possess specimens of this species from Professor Bailey himself, I could scarcely have recognised it from the brief notice he has given of it in 'Silliman's Journal,' and still less from the figure which accompanies it. The fact is, the characters which he attributes to it are now shared in common with other species, and we have to look for other distinctive marks. In some points, the species is allied to *A. Roperiana,* being apparently quite circular, and having the base of the segments square, or nearly so. An additional resemblance is also found in the median lines, which scarcely cover the central point, being arched at the top, then contracted, and lastly expanded, though not to the same extent as in the species just mentioned. Professor Bailey's figure represents the base of the segments as decidedly curved as in *A. Marylandica,* but they are more nearly square, and in some valves quite so. The umbilical lines radiate from the upper half of the median lines, and are sometimes branched. There is an angular bend, nearer to the outer extremity than in any other species, and at each angle the minute spine-like process indicates probably the base of a ramulus. This may also be seen at the base of the median lines. The areolation is conspicuous. The number of rays, according to Bailey, varies from seven to thirteen, or more; in my specimens they are from ten to twelve. The frustule, when perfect, is very convex.

16. *Asterolampra Roperiana,* n. sp., Grev.—Valve circular; hyaline area centrical; areolated segments square at the base, almost equal; rays seven; median lines passing round the central point in a semicircle, then contracted below, and lastly widely expanded. Diameter ·0028″ to ·0066″. (Fig. 14.)

Hab.—Indian Ocean, in soundings made by Captain Pullen, in 2200 fathoms.

It is unnecessary to repeat the remarks which I have already made on this most interesting diatom, as constituting

a link between the last and the present section. In fact, had the two median lines united *at* the central point instead of being carried just *round* it, it would have been included in the last section. In other words, it would have been an "*Asteromphalus*," instead of a "*Spatangidium*." The six perfect rays are broad, and equal to the margin, like those of De Brébisson's *Spatangidium heptactis*. The umbilical lines have an angular bend, which is so obscurely developed as to be liable to be overlooked; but the indication of the bend in the median lines, towards the margin of the hyaline area, is more conspicuous. When carefully looked for, however, they will be perceived without difficulty. I have even succeeded in tracing in two specimens very slender ramuli, passing from the angles of the bend to the angles at the base of the segments, exactly as in *Spatangidium heptactis*; but to do this requires the most careful adjustment possible, and such a management of illumination as to throw the umbilical lines, and ramuli, and edges of the ray cavities into a *light* definition. The umbilical lines, including the median ones, are robust, and the areolation rather large. The valves seem very constant to the characters given, as I have tested by an examination of above a dozen specimens. In one only did the median lines vary, in becoming widely sub-parallel, instead of diverging. Perfect examples are very rare. The individual figured is the most perfect, but by no means the largest in my cabinet.

17. *Asterolampra Shadboltiana*, n. sp., Grev.—Areolated segments square at the base; umbilical lines radiating from the arch of the pyriform median lines, with the angular bend about the middle; rays seven, terminating considerably within the margin. Diameter ·0031″. (Fig. 19.)

Hab.—Indian Ocean, in soundings obtained by Captain Pullen, in 2200 fathoms.

Mr. Roper very kindly sent both his accurate drawing and the slide containing the valve of this interesting species for my inspection; and I have since been so fortunate as to discover a second example for myself, so minutely similar that the engraved illustration might have been taken from either specimen. It seems to be a really well-marked diatom. Its nearest ally is perhaps *A. Brookei*, from which it is separated by the very different median lines, and by the angular bend being more in the middle of the umbilical lines. If the termination of the rays so much within the margin of the valve, and singularly short median ray, prove permanent characters, they will serve still farther to distinguish the present species. I suspect, also, that, as in *A. Roperiana*,

A. heptactis, and *A. Arachne*, the number of rays may be more constant than is generally the case in the group. The areolation is rather large.

18. *Asterolampra heptactis.*—Segments square at the base; rays seven, six of them broad, linear, subarcuate, the median one in a broad shallow groove; umbilical lines with a ramulus proceeding from each angle of the bend; areolation large. Diameter ·0018″ to ·0070″.

Spatangidium heptactis, De Bréb., Bull. Soc., Linn. de Normand., vol. iii, pl. 3, fig. 2.
Spatangidium Ralfsianum, Norm., Grev. Mic. Journ., vol. vii, p. 161, pl. 7., figs. 7, 8.

Hab.—Peruvian Guano, De Brébisson. Californian Guano, R. K. G. Atlantic soundings, Mr. Roper.

The extraordinary discrepancy between the figure, with part of the character in De Brébisson's paper above quoted, and the numerous specimens of the diatom itself, which I had examined, led me formerly to regard Mr. Norman's *Spatangidium Ralfsianum* as a distinct species. The broadly ovate outline of the valve delineated by De Brébisson, and the statement in his specific character, that the median ray was the longest, were opposed to my own experience; for I had ever found the valve broadest in the transverse direction, and the two lower lateral rays the longest. I still consider that my figure 8, above quoted, is typical of the species, as it agrees with the vast majority of specimens. While, however, I was supported in my view by some diatomists, others were against me, and I am at length satisfied that we had the same organism in view. Among some careful drawings of his own making, which Mr. Roper kindly permitted me to consult, are two of this species, and in one of them there is a slight approach towards a broadly ovate outline, and the median ray is the longest; but this is decidedly an exceptional case, unless, indeed, the Peruvian frustules differ in contour from those of California. There is a curious feature in this species which I did not formerly notice: the very slender ramuli which proceed from each angle of the bend in the umbilical lines terminate at the angles of the areolated segments, in a line with the margin of the broad rays; the consequence of which is, the two small spaces enclosed by these ramuli, at the base of each of the segments although they form a part of the hyaline area, are excluded from the basal portion of the ray. It may be observed also, that as in this fine species, as well as in *A. Roperiana*, the angular bend is distinctly connected with a system of ramification, it may

be inferred with some degree of confidence, that it is an important character when met with in other species. Little spine-like processes are seen to project from the angles in several allied forms, and may be the basis of similar ramuli. In the diatom under consideration, the base of each ramulus is conspicuous, but it appears at first sight to stop abruptly, and it requires very careful adjustment to trace the fine continuation to the angle of the segments. In other species, while the spine-like base is sufficiently obvious, the very delicate continuation may escape observation altogether. The colour of the valve is very pale yellow; the areolation larger than in any other member of the group.

19. *Asterolampra Arachne.*—Valve broadly ovate; hyaline area very small and eccentrical; areolated segments curved at the base, the upper one very widely, the lateral ones sharply; umbilical lines two, lateral; median lines dilated upwards; rays five, the two superior ones curved upwards, widely apart. Diameter about ·0021″.

Spatanidium Arachne, De Bréb., Bull. Soc. Linn. de Normand., vol. iii, pl. 3, fig. 1.

Asteromphalus malleus, Wall., Trans. Mic. Soc., vol. viii, p. 47, pl. 2, fig. 11.

Hab.—Peruvian Guano, De Brébisson. In *Salpæ,* Indian Ocean, Dr. Wallich. Indian Ocean, in soundings at 2200 fathoms, made by Captain Pullen.

It would be fortunate for the student if diatoms were in general as faithful to their characters as this remarkable species. It is one of the few belonging to the present group, of which it may be said that the number of rays is really constant. Their disposition is also very peculiar. The hyaline area is so small as scarcely to be perceived at first sight, being composed merely of the very short suddenly dilated bases of the four perfect rays and the space enclosed within the short median lines. The rays are attached to the sides of the median lines, nearly the whole of which they occupy. The upper pair turn their backs, as it were, on the lower pair, curving outwards and upwards, and bear much the same relation to the median lines as the horns of an ox do to the frontal bone. The lower pair of rays are straight, and point laterally downwards, forming a group of three with the median ray. The median lines also exhibit a character peculiar, I believe, to this species, in not being united at the top; they do not even incline towards each other, but stop abruptly, leaving the intervening space in juxtaposition with the base of the upper areolated segment. Another anomaly occurs in this part of the valve, in the segment just mentioned being unsupported by an umbilical line. The areolation is large; and

the colour of the valve, even when mounted in balsam, brownish yellow. Two specimens only have occurred to me, in the Indian Ocean soundings.

20. *Asterolampra Sarcophagus.*—"Valve oblong, with a slight constriction near each extremity; basal ray plane, and continuous with one of the true rays; sutures plane; cellules very large. Length ·0018″; breadth ·0009″."

Asteromphalus Sarcophagus, Wall., Trans. Mic. Soc., vol. viii, p. 47, pl. 2, fig. 12.

Hab.—Indian Ocean, from *Salpæ*, Dr. Wallich.

As I have not had an opportunity of examining this very curious diatom, I give the specific character in Dr. Wallich's own words. The form of the valve is so extreme a deviation from the otherwise more or less orbicular shape of the entire series, that an impression almost forces itself upon the mind that it is simply a malformation. Dr. Wallich does not mention how many individuals have come under his notice, but he has probably seen a sufficient number to satisfy him that its eccentricity of outline is permanent. It is most nearly related to *A. Arachne;* for if we remove the terminal ray (which in many species may be either present or absent), the five remaining rays would occupy the relative position which they hold in that species, as well as the same direction; one pair of perfect rays pointing upwards, the other pair downwards. In both species also the areolation is large.

Among several frustules of which I have only seen single specimens, and whose position is doubtful, is a minute and beautiful valve, of which I give a figure (fig. 20). It is allied to *A. Hiltoniana* and *A. flabellata*, but cannot be satisfactorily referred to either. The lowest pair of umbilical lines are curved downwards, as in the former species. The median lines are parallel, and continued to the edge of the hyaline area, or, in other words, to the base of the median segments, in a decidedly square manner. The valve, at a first glance, is most conspicuous for the large size of the hyaline area and the consequently rapidly attenuated rays; but this may prove to be a worthless distinction. It is only ·0018″ in diameter. I shall not attempt a formal character, but it may bear, for the sake of convenience, the provisional name of *A. stellata.* It occurs in the Indian Ocean soundings.

Asteromphalus centraster, of Dr. C. Johnston, from Elide Guano ('Mic. Journ.,' vol. viii, p. 12, Pl. I, fig. 10). I cannot speak of with any certainty. The rays, in being continued like distinct bars, or the ribs of an umbrella, from the central point to the margin, are unlike those of every known species of the group. There is evidently no true median ray.

ON THE STRUCTURE OF CARDUELLA CYATHIFORMIS. *A contribution to our knowledge of the* LUCERNARIADÆ. By Prof. ALLMAN, F.R.S., &c. &c.

IN the month of August last, during a short sojourn among the Orkney Isles, my attention was directed by Mr. Gilchrist of Stromness, to a little Lucernarian zoophyte, which he had discovered attached to stones near low-water-mark, in the neighbourhood of that town.

The little animal proves to be identical with the *Lucernaria cyathiformis* of Sars; but its characters are such as to convince me that it must be separated from the true *Lucernariæ*, and assumed as the type of a distinct genus in the family of the *Lucernariadæ.* That I am justified in this view, will, I think, appear from the following description :—

Fam., LUCERNARIADÆ.

Gen., CARDUELLA, mihi.

(*Name.*—A diminutive noun from *carduus,* a thistle, in allusion to its form.)

Gen. Char.—Body stalked; tentacles capitate, not tufted, springing from within the margin of a circular disc in a single series.

C. cyathiformis, Sars.—Body urceolate; peduncle dilated at its base into a disc for attachment; tentacular circle interrupted at about eight nearly regular intervals, by the non-development of certain tentacles.

Synonym.—*Lucernaria cyathiformis,* Sars, in Fauna lit. Norveg.; Johnston, Brit. Zooph., 2d Ed., p. 475, fig. 86.

Hab.—On stones near low-water-mark.

Localities.—Coast of Norway, *Sars;* Island of Arran, Scotland, *Rev. D. Landsborough;* Stromness, Orkney, *Mr. Gilchrist* and *G. I. A.*

Carduella cyathiformis is about half an inch in height. The body is hemispherical posteriorly, where it is seated on the summit of the peduncle; it then contracts behind the tentacular circle, and then again expands into a wide circular disc, whose margin is not produced into rays, as in the true *Lucernariæ,* and which has the mouth in its centre. The tentacles, slightly tapering from the base, and each ending in a spherical capitulum, do not, as in *Lucernaria,* spring from the edge of the cup, but from a circle situated at some distance within it, and in the fully expanded state of the animal extend about as much again beyond it.

The tentacular circle is interrupted at four nearly regular

intervals; but all the tentacles are situated in a single circle, and never form tufted groups as in *Lucernaria*.

Each of the four interruptions in the continuity of the circle of tentacles is caused by a single tentacle having that at each side of it arrested in its development, so as to present under the lens the appearance of little conical papillæ (Pl. V, fig. 3, *m*), while the developed tentacle, situated between the two arrested ones, is invariably bent over the edge of the cup in the expanded state of the animal (figs. 1, 3,) and thus renders the interruptions in the circle still more obvious. Not unfrequently, other interruptions are observed in the tentacular circle, caused by a similar abortion of one or more tentacles; but these are less regular in position, and less constant in occurrence, than those just described.

In the centre of the oral disc is a prominent four-lobed mouth, and the extremities of the four generative bands may be seen projecting from below each angle of the mouth, and distinctly visible through the disc, by the greater depth of their colour.

The peduncle is distinctly annulated both in the extended and contracted state, and terminates below in a little disc-like dilatation, by which the animal fastens itself to the rock; but I cannot find that it has the power of detaching itself when it has once become fixed.

The colour of *C. cyathiformis* is a brownish-red, with the stomach and generative bands conspicuous, by their deeper colour, through the semi-transparent walls of the body; while, just behind the bases of the tentacles, the body is marked by a deep-brown circle; and four paler lines, separated from one another by equal intervals, extend backwards from this circle to the summit of the peduncle.

It was a very frequent thing to meet with two individuals growing from a single basal disc; but this I believe to be a case of simple fusion from contiguity, and not an example of gemmation or other form of zooidal multiplication.

Carduella cyathiformis is one of the most elegant members of our littoral fauna, and rarely will the wanderer along the shore at low tides have his search more amply rewarded than by the capture of this charming little zoophyte.

Anatomy.—A transverse section (fig. 4) made about the middle of the body, or a longitudinal section (fig. 3) passing through the axis, shows an outer bell or umbrella (*a*), traversed in its axis by a quadrilateral, elongated stomach (*b*). In the walls of this stomach, along each of its four angles, runs a double lobulated band (*c*), which projects into the cavity of the stomach, and is the seat of the ova or spermatozoa.

From the outer side of the walls of the stomach there extend to the umbrella eight membranous vertical lamellæ (figs. 3, 4, *d*). These are so arranged, that from each of the angles along which one of the four generative bands runs two lamellæ are given off, and thence diverging at a wide angle, are attached by their outer edges to the inner surface of the umbrella, along a longitudinal ridge (*e*), which also gives attachment to one of the lamellæ of the neighbouring pair. There are thus four of these ridges, each giving attachment to two lamellæ, and situated alternately with the four angles of the stomach to which the opposite edges of the lamellæ are attached.

The result of this arrangement is the formation of eight spaces, four of which (*f*) are situated externally, while the other four (*g*) alternate with these and lie internally.

The four outer spaces are closed above, and their roof thus forms the oral disc (*h*) of the animal; while the four inner spaces are open, and allow a needle to be passed down along the side of the stomach the whole way as far as the peduncle.

Each of the four ridges, along which the vertical laminæ are attached to the inner edge of the umbrella, seems to be traversed through its entire length by a canal. They are visible in the living animal through the walls of the umbrella, where they appear as four pale-coloured lines, extending symmetrically from the summit of the peduncle as far as the tentacular circle.

Running along the bases of the tentacles, so as to form a continuous circle at some distance within the margin of the disc, is a deep reddish-brown line (*i*), which I have no hesitation in viewing as a circular canal, into which the tubular tentacles all open.

Upon the inner surface of the stomach are eight longitudinal rows of tubular appendages (*k*), two rows being situated in each of the four intervals between the generative bands. They are finely ciliated on their surface, and have their walls loaded with large thread-cells.

I have not satisfactorily made out the structure of the peduncle; but it seems to present the principal parts demonstrable in the body, namely, the umbrella, stomach, and generative bands, compressed into a smaller space and less distinguishable from one another.

Round the margin of the umbrella runs a band of circular muscular fibres (*l*), which performs the office of a sphincter in closing the mouth of the umbrella during the contracted state of the animal; while other fibres radiate in the oral disc, where they may be seen converging from the circular

canal at the base of the tentacles towards the central stomach.

In the ova (fig. 5), the germinal vesicle and germinal spot are distinct; and the spermatozoa (fig. 6) present a characteristic hydrozoal form, consisting of conical corpuscles, with the caudal filament attached to the broad end of the cone.

Homologies.—As to the true import of the structure now described, it will be easily seen that we have in it a genuine hydrozoal type, notwithstanding a certain superficial resemblance to the structure of the *Actinozoa.* The point which at first sight seems to remove it most widely from the *Hydrozoa,* and approximate it to the *Actinozoa,* will be found in the presence of the vertical lamellæ which connect the stomach with the outer wall of the animal. A little attention, however, will show that these must on no account be confounded with the radiating lamellæ of an *Actinia,* from which they differ entirely in their arrangement and relations.

The axile stomach of *Carduella* is exactly the *manubrium* of a Medusa, while the external body-walls correspond to the *umbrella;* and if I am correct in my interpretation of the appearances which lead me to believe in the existence of longitudinal and circular canals, we have in them the exact representatives of the radiating and circular canals of the gastro-vascular system of a Medusa.

As to the homology of the oral disc, I cannot help seeing in this muscular membrane the representative of the muscular *velum* of a gymnophthalmic Medusa, which, instead of being, as in the Medusa, free towards the axis of the animal, is here united to the stomach, while it is at the same time extended and so folded into plaits, as to form by the union of these plaits alternately to the stomach within, and to the umbrella without, the four pairs of vertical lamellæ; and although what we know of the development of the *velum* in the Medusa can scarcely be said to give any direct support to this view, it certainly is not inconsistent with it.

It will now be seen that it is with the *gymnophthalmic,* rather than with the *steganophthalmic* Medusa, that the affinities of *Carduella* are to be sought. We have, indeed, only to conceive of a gymnophthalmic Medusa, with its stomach (manubrium) united to the umbrella along four equidistant longitudinal lines through the medium of a peculiarly plaited velum, in order to convert it, so far as regards the most important points of its structure, into a *Carduella.*

On the Development *and* Structure *of the* Diatom-valve.

By G. C. Wallich, M.D., F.L.S.

In a paper recently published in 'The Annals and Magazine of Natural History,' I endeavoured to show the unfitness of the valves of the Diatomaceæ as standard tests for microscopic lenses, and based my objections to their employment on the variable character of the markings in different individuals of the same species, in the same species under varying conditions of development, and in the same specimen under different methods of examination. In dealing with this subject, I purposely selected *Pleurosigma angulatum* and *P. balticum,* the forms most frequently referred to, without assuming, for a moment, that the markings of these, or any other diatoms, are of sufficient importance, in a biological point of view, to entitle them to interest; and solely because it became imperative on me, whilst condemning tests hitherto relied on, to prove that some of those most constantly in use, and in the delineation and description of which the greatest pains has been taken by writers, exhibit characters irreconcilable with the structure usually assigned to them.

In the following observations, I shall principally endeavour to prove that growth does not take place in the diatom valve, after its primary development; and that the variation observable in the size and markings of different individuals of the same species is not only consistent with this view, but naturally follows from it.

The mere discussion as to whether the surface of a valve exhibits this or that kind of markings, so long as no higher purpose is in view than the production of certain appearances under the microscope, and the claim of superiority for the instrument whereby the most Protean aspects are engendered, must always remain barren of scientific results. For we are bound not only to see, but to comprehend the relation of one portion of minute structure to another, before we are in a position to draw serviceable inferences from it. It is well understood, by all who have had experience in microscopic manipulation, that great caution is necessary in pronouncing upon the precise structure of an object; and that, under imperfect adjustments, either as regards the object or the instrument, an indefinite amount of variation may be made apparent. This is especially the case under the employment of the higher powers. For, although the definition of the entire series of objectives, manufactured by our leading opticians, may be said to be equally perfect, a variety of

conditions are essential to secure accuracy of observation, and these can only be fulfilled under the exercise of the strictest vigilance and judgment.

But whilst the minute structure of the diatom-valve may be deemed by some persons unworthy of the labour that has been bestowed upon it, it is indisputable that the correct exposition of that structure involves a question, quite as important, perhaps, as any we have to encounter in the whole course of vegetable physiology; and however cynically some of our intellectual eagles may affect to treat the subject, they may rest assured that no little honour awaits the observer who shall place the laws by which it is governed in an intelligible light.

Why, let me ask, does one organism present peculiarities in the arrangement of its cell-wall which do not occur in another immediately allied to it? Why do we find organisms belonging to the same group, formed on the same general plan, surrounded by the same influences, and deriving nourishment from the same medium, vary so remarkably in the disposition of one of their elements, in which we should least expect to meet with variability? Thus, amongst the Diatomaceæ, why do we observe such differences between the arrangement of the siliceous particles in *Triceratium* and *Campylodiscus*, *Campylodiscus* and *Pleurosigma*, or *Pleurosigma* and *Pinnularia*, and so on with the remaining genera? As nothing in nature is, or indeed can be, fortuitous, some law must operate in bringing about these differences. Although as yet ignorant of the nature of that law, there is no reason whatever why we should remain so. Day after day brings forth fresh facts, in elucidation of the complicated scheme of creation; and no one can tell, therefore, how great a length of the chain of knowledge may be consolidated, by the addition of a link snatched from objects holding no higher place in the scale than the unpretending diatom.

Other more startling discoveries have been effected, and have earned for the discoverers greater *éclat;* but it is doubtful whether any have surpassed in physiological value Schwann and Schleiden's enunciation of the theory of cell-formation. On this basis the study of the entire organic world may be said to rest. It is the groundwork of our acquaintance with the structure of every living thing, from the lowest protophyte up to man. But there is a link, yet beyond that point, which requires to be filled up and riveted. I allude to the law that presides over the development of the cell-wall; and this, I conceive, can hardly be studied more advantageously than amongst the Diatomaceæ, the indestruct-

ible nature of which, coupled with their extreme transparency and the already understood chemical relations of their siliceous element, renders them so well fitted for the inquiry.

It is admitted on all sides that the rules by which species have heretofore been established demand material modification. Amongst the Diatomaceæ, a line, a dot, a minute spine, or a variation in size or outline, amounting, relatively speaking, to nothing more than we see occurring amongst individuals of the same species of every animal and plant in nature, has been accepted, by some observers as of sufficient moment to constitute a specific character. Almost every microscopist has fallen more or less into this error. But it is by no means an error confined to one class of observers; for entomologists, botanists, and conchologists are in exactly the same predicament. So that our knowledge of the minute Fauna of the globe, after all, is but in the same state as that of other branches of natural history, making due allowance for the multiplied difficulties by which microscopic investigation is specially beset.

Now, in the case of the Diatomaceæ, the leading generic characters are taken from the configuration of the siliceous valve. The sooner, therefore, that we gain such an insight into the law which regulates the deposit of the silex, as shall enable us to judge how far the differences of configuration may be dependent on chemical or molecular forces, and how far on the inherent property of the organisms themselves, the sooner shall we have it in our power to establish a natural classification, and to simplify, by rendering determinate, the methods of investigation.

We have before us the phenomenon of a mineral, eliminated or secreted by what we are pleased to denominate a simple cell, in a state of the utmost purity, and assuming definite forms, which may be said to hold an intermediate position between crystallization and simple molecular aggregation. We know the fact, but as yet we know absolutely nothing of the causes producing it. Surely then the investigation of such a problem is worthy of the best efforts of the microscopist; and from this point of view, even the "dot" may exercise a world of significance.

But whilst it is necessary that we should possess a clear idea of the structure of the siliceous wall of the diatom, it is by no means essential that we should have at our finger ends the precise nature of the surface in the more minute and subtle forms, or indeed in any save those that are typical and most easily revealed. If analogy means anything at all,

it surely authorises us to accept as most closely allied in structure those forms which, by universal consent, have been arranged side by side. We are sure to meet with stronger and more reliable analogies amongst the several species of the same genus, than amongst those of distinct genera. The statement of the one fact is but a statement of the other. And, for this reason, it is obvious that, in microscopic investigation, we are warranted in resorting to the most strongly marked and most readily observed species of a genus, when we attempt to draw general conclusions regarding its organization.

I allude just now more particularly to the genus *Pleurosigma,* of which a species, *P. angulatum,* has been handed down from writer to writer, both in Great Britain and abroad, as the one, *par excellence,* presenting us with typical structure. That it does exhibit structure identical in every essential particular with that observable in the rest of the species of that genus is undeniable. But, although by no means a difficult object for a quarter-inch lens of good construction, the markings on its valves are much more minute and delicate than is the case with other species; and accordingly the risk of misinterpretation, when it is viewed under higher powers, is necessarily augmented. I shall therefore select two other forms as typical of the rhomboidal and quadrangular structure, in which the characters can be made palpable both more easily and more distinctly.

Before entering, however, on a description of the structure in *Pleurosigma,* I would briefly point out the manner in which it appears to me the Diatomaceous frustule is developed; and to what extent the variations of conditions, to which it is subject during such development, seem likely to affect the siliceous deposit.

In the first place I would mention, that there is no evidence of growth proceeding continuously in the diatom-valve—if by growth be meant the increase and extension of the entire structure in every direction, as occurs in the higher orders of the vegetable kingdom. Some writers have endeavoured to account for the variable character of the striation in certain species, by asserting that, although the number of striæ in a minute fractional part of an inch is subject to considerable variation, the total number of striæ on the valves of all individuals of the same species or varieties is not liable to the like amount of deviation. In other words, they consider that the siliceous valve is capable of continuous growth; and that, whilst no fresh striæ are added to the valve, the distance between the several striæ may be augmented. Others again

modify this view by supposing that an addition may take place to the actual number of the striæ.

Now, whilst I fully admit the correctness of the first of these premises,—namely, that whilst the total number of striæ on a valve is nearly uniform in all the individuals of a given species orvariety, the number of striæ upon the fractional part of the valve admits of very great variation,—I dissent entirely from the opinion that the number of the striæ in a fractional part of a valve is capable of modification, either by the extension of the valve through growth, the total number of the striæ remaining the same, or by additional striæ being produced within the limits already attained.

The fact is, that the variation in the size of the valve and the number of its striæ proceeds, *pari passu,* during the progress of division, but not subsequently. Growth may take place to the extent of fresh siliceous matter being secreted along the margins of the valve, its depth being thereby somewhat augmented; but it is highly probable, for reasons which shall immediately be adduced, that the connecting zone, by which the young valve is protected during its secretion and consolidation, determines the limit of the dimensions to be attained by it; and although the young valve may still have to undergo a certain degree of consolidation, the whole of the characters, as we observe them under the microscope, are indelibly and unalterably impressed upon it, either before or almost immediately after its liberation. In like manner, the two rings of the connecting zone grow lengthwise by secretion of fresh siliceous matter at one of their margins only—as was shown by me in a former communication to the 'Microscopical Journal' (vol. vi, p. 224)—and they are thus enabled to slide out, one from the other, telescope fashion, and to accommodate themselves to the increase of their contents during division. The last feature is strikingly manifest in such genera as *Biddulphia, Amphitetras, Isthmia, Grammatophora,* and others.

I believe I am quite correct in stating that it very rarely, if ever, happens that an imperfectly developed—that is, an immature—valve is found associated with one of the parent valves from which it was derived, after the separation of the parent connecting zone; whereas we constantly meet with such a combination prior to that event. In the next place, whensoever we find, through the evidence of the still persistent connecting zone, that a young valve has but recently been perfected, its structure presents no peculiarity whereby it can be pronounced to differ from the parent valve with which it is associated. We frequently meet with frustules, furnishing incontestable evidence of recent division having

taken place, as just stated, equalling in dimensions the largest specimens of the species to which they belong. And, lastly, we never meet with such differences in size and markings as would, of necessity, result, did growth continue in the terminal parent valves of an elongated filamentous species; whilst the central or most recently produced valves exhibit only the size and markings attained by the parent valve at the period at which the first occurrence of division intervened.

A further and most remarkable confirmation of the view, that growth does not take place in the valve after its liberation from the parent connecting zone, is, I submit, derived from an abnormal form of *Triceratium favus,* a figure and description of which are given by Mr. Brightwell, in the 'Quarterly Journal of Microscopical Science,' vol. i, p. 246. In this specimen, an oblong portion, equal in extent to about one third of the entire valvular surface, is cleft out, as it were, from one of the angles. It is evident that, from whatsoever cause this configuration occurred, that cause must have taken effect whilst the valve was still in the plastic condition, to which reference has been made; for the cleft margin is fringed by a regular series of quadrangular cellules, such as we frequently observe along the inflected edge of the valve in the species under notice. As the specimen must have been subject to the action of acid or heat, before its intimate structure could have been examined and figured, it is equally evident that the valve had attained its mature and perfected condition. It should be borne in mind that the valve is of normal outline and configuration on the remaining surface. There is no projection from the sides or angles, indicating that the object to which the abnormal development was due had taken effect after the complete valve had been deposited; but, on the contrary, it is clear that such object must have presented an obstacle to the complete development of the valve whilst it was retained within its parent connecting zone. From the shape of the emarginate portion, it would appear to have been produced by growth taking place around some substance, such as a calcareous or siliceous spicule. From its not having been retained *in situ,* we may infer—either that, being siliceous, it had broken its way out at the deficient angle; or, being calcareous, that it had been dissolved during the operation of cleaning by acid. It is hardly possible to conceive that an object could pierce the already perfected and consolidated diatom-valve. But, supposing that possible, it is certain that fracture must have resulted, or that an extent of valvular surface must have been displaced of equal bulk to the emarginate space.

It may be asked, then, to what cause are we to attribute the

variation in dimensions that occurs so frequently? If not to growth, in the ordinary sense, to what other cause? It is attributable, in the first place, to increased or diminished supply of nutrition to which the species happens to be subject; acting by the production of differences between the parent and the young valve, wholly inappreciable to our vision, notwithstanding all our appearances, but yet quite capable of effecting the variation in question, through the intervention of a multitude of individuals. In strict truth, no two valves of the same frustule can be of the same size; for the new valves, being formed within the connecting zones of the parent frustule, must be smaller than these. In answer to this it may be urged that, in the usual course of growth, they reach the dimensions of the parent valve. But unless we are prepared to admit that the latter obligingly cease growing for a time, to permit of the requisite uniformity in size being attained, it will be seen that this objection is invalid. The difference in the two valves arising from the last-mentioned cause, however infinitessimal it may appear in the case of the individual, becomes, nevertheless, all-powerful when operating through vast successions of individuals; and is, therefore, of itself sufficient to account for the variations we witness.

The main source of difference, however, in the size of the valves of any given species is derived from the peculiar idiosyncrasy of the sporangial frustule. The large dimensions that frustule attains in many cases is well known. And, although the precise history of the produce of the sporangial cell still remains doubtful, there is, I believe, quite sufficient evidence forthcoming to show that the prevailing opinion, as to the great variation in dimensions of the new brood, is quite correct. If we bear in mind the vicissitudes of climate and locality to which the sporangial cell may, under certain circumstances, be subjected, we can readily understand, moreover, how increased or diminished sources of nutritive matter, dependent on those vicissitudes, may affect the produce of that cell towards either extreme.

In *Isthmia*, a genus offering remarkable facilities for the detection of differences between the size of the old and the new valves of the frustules, after careful and oft-repeated examination, I have been quite unable to detect any differences independent of the causes associated with the connecting zone to which reference has already been made. In this genus and in *Biddulphia*, the overlapping of the two rings of the connecting zones is more strikingly manifest, perhaps, than in any other forms, and the entire frustules are often of such magnitude as to enable us clearly to distinguish the contrast,

in internal area, of the two valves, arising from this source. In *Isthmia,* we also sometimes observe great variation as to length and breadth of frustules growing upon the same object. But it will be found that these marked differences do not occur in the same filament, but on separate ones; and that the primary frustule, or rather that valve of it by which epiphytic adhesion was first secured, frequently does not exceed in size the smallest of any of the other neighbouring terminal frustules.

After similarly extended observation of the compressed filamentous genera, I have never found any ground to alter my views respecting the determinate period during which the siliceous value may be said to increase; and, as an example in point, and one which, for several reasons, is amongst those best fitted to test its correctness, I would mention having carefully measured, by means of Ross's screw micrometer, frustules of the three species of *Rhabdonema,* at intervals, in filaments numbering as many as a hundred individuals, without the discovery of any difference in the length of the valves of sufficient magnitude to be referable to any other cause. When it is recollected that, in this genus, the frustules are annulate, and the entire structure would appear specially liable to variation in size, from the repetitive process alternating, as it were, with the extension of the frustule through the deposition of the annulate portions, it will be admitted that a more satisfactory test genus could not have been selected. I would add, for the guidance of those who may desire to repeat these measurements, that a source of fallacy exists which must be carefully guarded against; namely, the change of apparent size depending on the structure under examination not being placed perfectly flat upon the surface of the slide. A very little management will, however, suffice to ensure the proper position.

As regards the cell-contents, and the gelatinous envelope by which the whole of the Diatomaceæ are, in a greater or lesser degree, surrounded, growth goes on, in all probability, indefinitely. The present observations must be understood to apply, exclusively, to the siliceous valve of these organisms; and are offered with a view to prove that the specific markings of any given form are definitely impressed upon it, either at the period when division is completed, or almost immediately afterwards; and that whatever may be the normal shape of these markings—that is to say, their primary form in the young valve—being disposed in a determinate order with relation to each other, and to the boundaries of the frustule, their ultimate configuration is determined, in a principal

degree, by the form of the frustule, and by the direction in which that form exercises a constrictive force, whilst the siliceous material of its valves is still in a plastic condition.

If we admit this proposition, we cannot fail to comprehend how materially the nature of valvular markings may be modified by any variation in the condition to which the parent frustule may be exposed during the period of division; and we at once recognise the futility of drawing specific characters from the mere numerical estimate of striæ within certain limits, or, indeed, from any structural peculiarities apart from such as are constant.

Much of the confusion that exists with regards to the "striation" or "lineation" of the Diatomaceæ arises, I conceive, from the vague manner in which these terms are employed to indicate different portions of the valvular structure. Thus, in *Pleurosigma,* the terms are used, by some writers, to indicate the lines presented to the eye by the coalescence of the several series of intra-linear spaces; whilst, by others, they are intended to denote the lines formed by the boundaries of those spaces. This last is certainly the correct view; and it is borne out by the circumstance that the outline and peculiarities of the intra-linear spaces are determined, as shall presently be shown, by the inherent order of the lineation, and not the lineation by the inherent development of the spaces.

In the 'Synopsis of British Diatomaceæ,' the valve of *Pleurosigma* is stated as being "striated; striæ resolvable into dots, which are frequently hexagonal." Other writers are also in the habit of alluding to "striæ composed of dots." From this definition it is impossible to gather whether the lines we observe crossing each other at certain angles are indicated, or the spaces bounded by the intersections of those lines. In reckoning the number of lines in the one-thousandth part of an inch, the measurements are evidently derived from the first of these points; whereas it is undeniable that the so-called "dots" occupy the intra-linear spaces. The number of "dots," and the number of "striæ," therefore, can never tally; and, for a similar reason, it involves a contradiction to say that the "striæ are resolvable into dots." It remains still a point of dispute whether the intra-linear spaces are depressions or elevations. It is not improbable that they are elevations in some species, and depressions in others. Fortunately, however, the solution of the question is a matter of no great moment for purposes of classification; and it becomes of still less importance when we bear in mind, that as a valve happens

to be viewed in one or other of its aspects, so must the appearance of elevations or depressions vary. At present, it is only in some of the more boldly-marked species that we can decidedly pronounce which surface of a valve is directed towards the observer. On this account I have adopted the use of the somewhat vague term, "intra-linear" spaces, to designate those portions in which the appearances of elevations or depressions occur, leaving the peculiar nature of such spaces to be dealt with in each separate case.

If we examine the valve of any of the most boldly-marked species belonging to the Naviculoid group of diatoms, as, for example, *Pinnularia distans, alpina,* or *lata,* we meet with what I conceive to be the simplest form of lineation, namely, a series of narrow, elongated, depressed "costæ,"—as they are very inappropriately termed,—arranged in transverse order on the surface of the valve, and rendered remarkably distinct by their superior degree of translucence, and the contrast they present in refractive power with the adjacent parts. Neither the depressed "costæ" nor the intra-costal spaces exhibit any trace of secondary markings. In proof of the "costæ" being depressions, it may be mentioned that, whilst the median line and nodule and the entire margin of the valves exhibit one uniform colour, usually a pale rose pink, the "costæ" partake of the faint-blue tint observable in the surrounding field of vision; and lastly, that, in accidentally fractured valves, the intra-costal spaces are left more or less entire, like the teeth of a comb, attached to the median portion of the valve, which is precisely the opposite of what would occur did the intra-costal bars constitute the thinnest portions of the valve, whilst the costæ are the thickest.

In the genus *Navicula,* we find this kind of structure modified, but in a slight degree; and this, it appears to me, has not been clearly shown heretofore, inasmuch as the very term "striæ," which is specially employed to indicate the structure, at once suggests the idea of projecting lines, or bands minutely scored across, at intervals; whereas the difference between the markings in *Pinnularia* and *Navicula* consists only in the depressed spaces in the latter genus being so minute as to admit of their arrangement, at intervals, in linear series across the valve, and thus appearing as unbroken lines under the lower powers of the microscope. In this instance, the definition, "resolvable into circular dots," is strictly accurate.

In the monstrosity which has been dignified with the name of "*Surirella craticula,*" we at times meet with the

striation of *Navicula,* and the canaliculate structure of *Surirella,* associated on distinct portions of the same valve. In a specimen in my possession, from Bengal, and a similar one from the Channel Islands, the central third of the valve is distinctly striated, whereas the two outer thirds exhibit the canaliculate character, in respect of which this form has been referred to *Surirella.* In vol. ii, p. 97, of the 'Journal of the Microscopical Society,' Professor Gregory has described a similar form as occurring in the "Mull deposit;" and alludes to the so-called "canaliculi" being "bars." Under my view of the structure in *Pinnularia,* to which genus the diatom in question bears much closer resemblance than to *Surirella,* the spaces between the bars are the analogues of the "costæ," whilst the bars constitute the intra-costal spaces. I would here beg leave to state that, in retaining the term "costæ," as ordinarily applied, which is much more applicable to the intra-costal spaces than to the parts which have hitherto received it, I am guided solely by the desire of avoiding inconvenience invariably attendant on changes of the kind.

In *Pleurosigma,* on the other hand, the intra-linear spaces constitute the strongest portions of the valvular plate. In *P. formosum* there exists good evidence to prove that the intra-linear spaces are occupied by elevated rhomboidal papillæ, which present facetted surfaces; whereas in *P. Balticum,* instead of rhomboidal elevations, we have four-sided flattened pyramids, presenting, as in the former case, four sets of lines, of which those bounding the spaces, and not those crossing them, are the predominant ones.

Again, taking into consideration the secondary internal valvular plate, the existence of which is constantly seen in some species, it is not improbable that such a structure may occur throughout the whole family, although incapable of separation in most examples. From the modified impress of the markings of the external plate found upon that beneath it—as, for example, in *Cocconcis*—it is clear that, to a certain extent at all events, the markings of the external surface of the primary plate are traceable on its internal aspect. Much additional evidence must, however, be forthcoming, before this question can be satisfactorily settled.

A good deal of misconception has arisen from the supposed analogy between the markings in *Triceratium,* in which hexagonal structure really occurs, and those in *Pleurosigma,* in which the appearance of hexagonal cellulation is only observable under deceptive instrumental adjustments. In the one case, the hexagonal spaces constitute the thinnest

portion of the valve, and fracture takes place through their centres; whilst in *Pleurosigma*, the intra-linear spaces, which are held, but erroneously, to be equivalent to the hexagonal spots, constitute the strongest portion of the valve, and fracture never takes place through them, save when undue force happens to be employed. That the error in this case originates in a misconceived analogy, is evident from the subjoined quotation:—"The valve is thinner and weaker at the parts occupied by the dots; so that the line of fracture corresponds to these parts." And again—"In those (*Pleurosigmas*) requiring the use of oblique light and stops, the line of fracture also corresponds to the rows of dots, provided the light is equally oblique on all sides; and the same appearances are presented by the dots in both cases, beginning with those in which they are large (as *Isthmia*), to those of moderate size (as in the species of *Coscinodiscus*), down to those in which they are extremely minute (as in *Gyrosigma*, &c.). Moreover, analogy affords us very strong confirmatory ground; for the Diatomaceæ form a very natural family, and if the dots are depressions in some genera, we might expect them to be so in others. Had these dots (in *Gyrosigma*) represented elevations, the valve would have been stronger at those points." ('Micrographic Dict.,' new ed., p. 34.)

If we take into consideration the outline of the more marked discoidal forms, for instance, *Triceratium* and *Coscinodiscus*, and contrast it with that of the Naviculoid group, such as *Navicula* or *Pleurosigma*, it appears to me that we might naturally expect to find the markings in the two types exhibiting some distinct relation to the outline. Now, in the genera which exhibit the honeycomb structure—that is, where we find the appearance of a number of little hollow cylinders, of considerable relative depth, and open outwardly in so far as the siliceous wall is concerned—the conversion of elementary circular cavities into hexagons is exactly what would result from pressure exerted equally in every direction. In a small but well-marked species of *Coscinodiscus*, *C. nitidus*, Greg., the markings are always circular, the distance between them being too great to admit of their shape being modified by the pressure of each cellule upon those adjoining it. The same holds good of a small *Triceratium*, closely allied to Mr. Brightwell's *T. punctatum*.

In *Isthmia* we meet with shallow cellules, or rather depressions, varying in different frustules, in different gatherings, and in different parts of the same valve, from irregular circles, to irregular hexagons, parallelograms, and pentagons, accord-

ing as they are situated on plane or curved portions of the valve; thus proving most clearly, that the figure of the cellules is modified, as I have asserted, by the configuration of the entire frustule.

Advancing from the discoidal group, presenting haxagonal cellulation, we are gradually led, first through *Campylodiscus,* and then *Surirella,* to the Naviculoid group, exhibiting what is called "striation."

In *Campylodiscus cribrosus* we meet with circular or subcircular markings. In *C. Hodgsonii,* the circular and the canaliculate are combined, or rather occur at definite portions of the valvular surface; the canaliculi being arrayed conformably to the curvature of the valve. This last feature is to be seen still more markedly in *C. spiralis,* whilst in *Surirella fastuosa* we have the connecting bond between *Campylodiscus* and the Naviculoid forms; specimens of *C. fastuosa,* from the Channel Islands, presenting a distinct flexure at right angles to the true axis of the valve, as in the last-named genus.

Although our knowledge of the precise share taken in the secretion of the siliceous valve, by the primordial utricle, is lamentably deficient, certain facts crop out, here and there, which it may be well to record under one head, with a view to facilitate further inquiry. We know, for instance, that the frustules of the Diatomaceæ, like the fronds of the Desmidiaceæ are encased in a gelatinous layer or envelope. In some genera, this envelope is highly developed; in others it is not so. But from the invarible obscurity of the markings upon all, until the siliceous surface is cleaned by the application of acids or heat, it is certain that such envelope exists indiscriminately in the whole tribe. Judging, therefore, from the impermeable character of the siliceous wall, it is highly probable that the gelatinous stratum is secreted by the primordial utricle, through the marginal aperture of the valve, much in the same way as the epiderm of the molluscous shell is secreted at the margin of the mantle. Like the latter, moreover, it is probably intended as a protection to the subjacent structure. Of its highly elastic nature we have ample proof, as was shown in a paper communicated by me to this Society a short time ago. We can hardly doubt its vitality, therefore; and we are thus furnished with presumptive evidence that the invisibility of the motile filaments, whose existence I endeavoured to demonstrate inferentially, is due to the same cause that enables this gelatinous stratum to defy our optical appliances.

Another element of difficulty in the resolution of valvular

structure consists in a portion of the connecting zone being sometimes projected under the surface of the valve, and faintly impressed with its markings, as we find to be the case in *Epithemia gibba, Stauroneis pulchella,* and *Nitzschia spectabilis.* In *Stauroneis pulchella* and *Cocconeis placentula,* the peculiar wavy appearance which is superadded to the valvular structure would appear to be due to this cause.

I cannot better describe the markings on the valves of *Pleurosigma formosum* and *P. Balticum,* than by comparison of what is seen in the first to a wafer-stamp, or neck of a gun-stock; whereas, in the last, we have the form of marking that would result, were an impression taken of a wafer-stamp, in which the rhomboidal figures were replaced by flattened four-sided pyramids. In both cases there are four facets, inclined at a moderate angle to the plane of the surface; and two of the four sets of lines they exhibit can be brought into focus more readily than the other two. The reason of this is obvious. The diagonal series in *P. formosum,* and the rectangular in *P. Balticum,* being arranged strictly on the same plane, are capable of being brought into accurate focus simultaneously. They constitute the thinnest portions of the valves. Whereas the longitudinal and transverse series in the first species, and the diagonal in the last, being constructed of a series of short zigzags following the rise and fall of the facetted portions, cannot be brought into focus at all points with equal exactness; and form the thickest portions of the valve. The distance, moreover, between the several sets of lines being different, the closer series are more difficult of resolution. The first-named cause is, however, by far the most powerful.

Without taking upon myself the unnecessary task of proving a negative, I would briefly state my reasons *seriatim* for rejecting, as wholly inconclusive, the arguments cited in proof of the hexagonal structure of *Pleurosigma angulatum,* and also the evidence based upon the photographic representation.

The analogy derived from what is seen in *Triceratium* and *Isthmia* has been shown to be fallacious.

It is admitted by the advocates of the hexagonal structure that, under imperfect adjustments of the microscope, "hexagonal dots" may be made to appear quadrangular or triangular; and that those dots which cannot be conceived to be really hexagonal may be made to appear so.

In *Pleurosigma Balticum* or *P. hippocampus,* by imperfect adjustments, the appearance of hexagonal structure may be produced quite as vividly as it can be made to appear in *P. angulatum.*

Inasmuch as the photographic representation so constantly appealed to is stated to be partly in perfect focus, and partly out of focus, whereas the structure is equally distinct on both parts, and the only difference observable consists in the reversal of the lights and shadows, it is much more probable that one portion was as much without the true focus as the other portion was within it.

From the woodcut of the photographic picture, it would appear that the thickness of the walls of the hexagonal cellules is equal to half of their diameter. Now, the striæ being stated to be composed of dots, and the lines being estimated at $\frac{1}{20000}$th of an inch apart, the walls must measure in round numbers $\frac{1}{100000}$th part of an inch in thickness; thus presenting a surface the outline of which ought to be readily resolved by the same powers that show the diagonal markings, —for instance, by a quarter-inch objective,—did the hexagonal structure really exist.

It is highly improbable that hexagonal structure should present itself in one species or group of a well-marked genus, whilst a totally different structure is admitted to exist in the other species of the same genus.

In proof of the rhomboidal structure, I beg, on the other hand, to offer the subjoined proofs.

Under the application of any powers, ranging from $\frac{1}{4}$ to $\frac{1}{12}$ of an inch focus, so long as definition remains unimpaired, the rhomboidal structure is invariably discernible; the diagonal lines being predominant and visible, with perfect clearness, in the case of the rhomboidally marked group, whereas the rectangular series is so in the other.

The object retained in one position on the stage, when viewed under a given power, say a $\frac{1}{12}$-inch objective and a low eye-piece, exhibits oblique lineation and rhomboidal facetted spaces, with perfect definition; whereas, by replacing the low eye-piece with a high one, and making any alteration of focus demanded by the change, the hexagon-like structure exhibits itself, but with imperfect definition.

By causing the rotation of the slide, containing either the rhomboidally or rectangularly marked forms, at every forty-five degrees a fresh series of lines will predominate, according to the direction of the illuminating rays; each of the four series being, of course, twice repeated in one complete revolution, and the change of series therefore taking place eight times.*

* As the longitudinal and transverse series of lines in the rhomboidal group, and the diagonal series of the rectangular group of *Pleurosigmas*, require much more careful adjustment than the predominant series, for

Were the structure hexagonal, these changes could not occur in the foregoing order or number; for, inasmuch as in any hexagonal arrangement only three series of lines are present, being disposed on the same plane, the changes to the predominant series would take place six times only, namely, at every 60° in a complete revolution, each series being twice repeated.

It has been pointed out by Mr. Hunt ('Journal of Microscopical Science,' vol. i, p. 175) that the boundaries of a portion of a valve, belonging to one of the diagonally marked group, to which moisture had accidentally gained access, were in strict accordance with the view of diagonal lineation; whereas they were not reconcilable with any other view of the structure. A similar fact may, at any time, be witnessed in balsam-mounted specimens to which air has gained partial access, or in dry mounted slides, affected by the ordinary atmospheric moisture.

Lastly, the lines of fracture, as before stated, invariably tally with the thinnest portions of the valves in the two groups, that is, with the diagonal series in the one, and with the longitudinal and transverse series in the other; a result at variance with the indefinite lines of fracture observable in true hexagonal structures.

Without reverting, then, to theoretical points, I would sum up the general conclusions for which I conceive sufficient evidence has been adduced. They are as follows:—

That the growth of the diatom valve ceases entirely, either at the period of its liberation from the connecting zone of the parent valve, or immediately afterwards.

That, subsequently to this period, no change of configuration takes place in the siliceous valve, except along its margin, where fresh siliceous secretion may, under certain conditions, be produced.

That the normal figure of all markings whatever is circular, or approaching thereto.

That these markings are arranged on the surface of the diatom valve in a determinate order, according to the inherent tendency of the species; but that the ultimate figure of those markings is due to forces exerted upon the young valve, whilst in a plastic condition, and retained within the connecting zone of the parent frustule.

And lastly, that variation in size, and in the degree of fine-

reasons already given, they may be left out of the proof, if the experimenter desires, without in any degree vitiating the result; for, in this case, the change to the predominant series only, would occur four times, instead of eight, in a complete revolution, namely, at each 90°.

ness or coarseness of the markings, is, within given limits, dependent on the conditions under which the sporangeal frustule gives egress to the germs of the new generation; but that the ordinary process of division is, of itself, sufficient to bring about great variation, when operating through a vast succession of individuals.*

* In the discussion which followed the reading of Dr. Wallich's paper, Mr. Wenham stated that, with an object-glass of his own construction, having a focal distance of about $\frac{1}{50}$th of an inch and a large aperture, he had ascertained beyond doubt, that in *Pleurosigma angulatum*, and some others, the valves are composed wholly of spherical particles of silex, possessing high refractive properties. And he showed how all the various optical appearances in the valves of the Diatomaceæ might be reconciled with the supposition that their structure was universally the same.—[*Eds.*]

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ORIGINAL COMMUNICATIONS.

On American Diatomaceæ. By Arthur M. Edwards, Esq., New York, U. S.

A paper of mine, on American Diatomaceæ, was read before the London Microscopical Society, March 30th, 1859, and published in their Transactions, in which an omission occurred which I herein wish to rectify. A mistake occurred in re-writing, so that the description of the species found at Charleston harbour, S. C., was left out. A paper on this subject, by the present writer, was read before the New York Lyceum of Natural History, February 21st, 1859, a copy of which is annexed:—

On the Microscopic forms of the Harbour of Charleston, South Carolina.

In the year 1850, Professor Bailey published in the 'Smithsonian Contributions to Knowledge,' a list of the microscopic organisms which he had found in mud collected from the logs of wharves, and from other situations in the harbour of Charleston, S. C., which contained two new species, besides many other curious forms; and in the year 1853, he described four species of Ehrenberg's genus *Auliscus*, three of which are also found at Charleston, though Bailey failed to detect them. Bailey's list is as follows:—

Actiniscus sirius, *Ehr.*
Actinoyclus bioctonarius, *Ehr.*
Actinoptychus senarius, *Ehr.*
Biddulphia pulchella, *Gray.*
Cocconeis scutellum, *Ehr.*
Coscinodiscus eccentricus, *Ehr.*
Dictyocha fibula, *Ehr.*
Eupodiscus Rogersii, *Ehr.*
* ,, radiatus, *B.*
Gaillionella sulcata, *Ehr.*
Navicula sigma, *Ehr.*
Pinnularia interrupta, *Ehr.*
,, didyma, *Ehr.*
,, lyra, *Ehr.*
Raphoneis rhombus, *Ehr.*
Stauroptera aspera, *Ehr.*
*Surirella circumstuta, *B.*
Terpsina musica, *Ehr.*
Triceratium favus, *Ehr.*
,, alternans, *B.*

Certain of these have been re-named by later observers,

or have been found to be synonymous with already described species, and should be designated thus :—

Actinocyclus bioctonarius, *Ehr.*	=	Coscinodiscus actinoptychus, *Edw.*
Actinoptychus senarius, *Ehr.*	=	Actinophœnia splendens, *Shad.*
Eupodiscus Rogersii, *Ehr.*	=	Eupodiscus argus, *Ehr.*
Pinnularia didyma, *Ehr.*	=	Navicula didyma, *K.*
,, lyra, *Ehr.*	=	,, lyra, *K.*
Raphoneis rhombus, *Ehr.*	=	Doryphora amphiceros, *K.*
Stauroptera aspera, *Ehr.*	=	Stauroneis pulchella, *W. S.*
Surirella circumstuta, *B.*	=	Tryblionella scutellum, *W. S.*
Gaillionella sulcata, *Ehr.*	=	Orthosira marina, *Ehr.*

Actiniscus sirius, Ehr., and *Dictyocha fibula,* Ehr., are neither of them Diatoms, and are most probably portions of the skeleton of a Holothuria.

Some two years back, I received from a friend residing at Charleston some of the so-called black "pluff" mud, taken from between watermarks, and which I found to be extremely rich in Diatomaceous forms. The following species were observed :—

Actinocyclus undulatus, *Ehr.*
Actinophœnia splendens, *Shad.*
Auliscus cælatus, *B.*
,, pruinosus, *B.*
,, punctatus, *B.*
Biddulphia rhombus, *W. S.*
,, aurita, *Bréb.*
Campylodiscus cribrosus, *W. S.*
Cocconeis scutellum, *Ehr.*
Coscinodiscus actinoptychus. *Edw.*
,, eccentricus, *Ehr.*
,, lineatus, *Ehr.*
,, oculus-iridis, *Ehr.*
,, radiatus, *Ehr.*
,, subtilis, *Ehr.*
Epithemia Hyndmanii, *W. S.*
,, musculus, *K.*
Navicula didyma, *K.*
* ,, maculata, *n. sp.*
* ,, permagna, *n. sp.*
Nitzschia scalaris, *W. S.*
Pleurosigma angulata, *W. S.*
Triceratium alternans, *B.*
favus, *Ehr.*
punctatum, *T. B.*
Tryblionella scutellum, *W. S.*
,, punctata, *W. S.*

The *Navicula sigma,* Ehr., of Bailey's list, is most probably synonymous with the *Pleurosigma angulata,* W. S., of mine. Those species marked with an asterisk (*) are new, and are characterised as follows :—

Navicula maculata, n. sp.=*Stauroneis maculata,* B., 1850.

"Lanceolate or elliptical; ends slightly produced and rounded; surface punctato-striate, with a large smooth central space." *Bailey.* To this description I have to add the following measurements: length ·055 in.; breadth ·00216 in.; striæ coarsely moniliform, 12 in. ·001 in.

Navicula permagna, n. sp.=*Pinnularia permagna,* B., 1850.

"Large, lanceolate on the ventral faces, with punctato-striate marginal bands, and a broad, smooth central stripe;

ends slightly rounded." *Bailey*. I have as yet only found this species in small quantities, and have been unable to make its measurements. There can be no doubt that these two species should be placed in the genus *Navicula*, as the seeming stauros in the first, the presence of which would seem to rank it in that of *Stauroneis*, is only a blank space, such as is seen in many species of *Navicula*, as *N. elegans*, &c. The presence of moniliform striæ in the second species removes it from *Pinnularia*, which is characterised by its markings being costæ, not resolvable into dots. Of *N. maculata*, I have specimens from Duval's Creek, near Enterprise, Florida, for which I am indebted to Dr. Christopher Johnston, of Baltimore, Md.

I here mention a fact that has come within my notice while examining this gathering. Smith's *Eupodiscus radiatus*, as described and figured in the first volume of his 'Synopsis,' is not the same as the form described under that name by Bailey in 1850. Roper has remarked this same fact ('Trans. Mic. Soc.,' London, vol. vii, p. 19), but was in some doubt until I had the pleasure of forwarding him authentic specimens of it from Bailey's cabinet, when he wrote to me that the examination of them confirmed his opinion that Smith was in error in referring the Thames diatom to that species. It is perfectly distinct, and a true Eupodiscus.

Since the above article was written, I have been lead, by the advice of Dr. Arnott, to reconsider the subject of the species, which I, in my paper on American Diatoms, called *Coscinodiscus actinoptychus*. This belongs to Ehrenberg's genus *Actinocyclus*, the species of which are characterised by the number of rays,—a loose character. It should therefore be placed in that genus for the present, the specific name being left blank until more is known of its natural history.

TRANSLATION.

Atmospheric Micrography. Observations *on the* Corpuscles *suspended in the* Atmosphere. By M. Pouchet.

('Comptes rendus,' March 21st, 1859.)

The atmosphere contains, in suspension, numerous corpuscles, consisting of the detritus of the mineral crust of the earth, animal and vegetable particles, and the minutely divided débris of the various articles employed in our wants. These various kinds of corpuscles are more numerous and more voluminous in proportion to the degree in which the atmosphere is agitated by the wind; and they constitute what we term "dust."

This "dust" being simply the deposit of the corpuscles carried in the atmosphere, it is evident that the attentive study of its composition is simply a microscopic analysis of the air.

The granules of mineral origin, partly going to form the dust, present but little variety. They are derived essentially from the detritus of the rocks which are exposed in the country where the dust is observed.

The débris derived from the animal kingdom consists chiefly of the following articles:—various animalcules in a dry state and of extreme minuteness, such as entozoa belonging to the genus *Oxyuris* and *Vibriones* of several species. I have often also noticed the skeletons of siliceous Infusoria, especially of *Naviculæ, Bacillariæ,* and other diatoms; fragments of the antennæ of Coleoptera; scales of diurnal and nocturnal Lepidoptera; fibres of wool of various colours derived from our clothes, often of a beautiful blue, bright red, or green; hairs of the rabbit, bat, &c.; the barblets of feathers; fragments of the tarsi of insects; epithelial cells; fragments of the skin of various insects; particles of cobweb. Twice only, in more than a thousand observations, have I observed one of those large ova of Infusoria having a diameter of 0·0150 mm., denominated by naturalists "cysts."

The corpuscles contained in "dust" belonging to the vegetable kingdom, observed by me, are the following:—frag-

ments of the tissue of various plants; a few ligneous fibres; more frequently fragments of cells and vessels; often hairs of the nettle and other plants; numerous filaments of cotton, usually white, but sometimes of various colours, also derived from articles of dress; some fragments of anthers and pollen-grains of malvaceous plants, of *Epilobium* and *Pinus;* spores of cryptogamous plants, but in very small number. Lastly, I have constantly noticed, and almost invariably where my observations have been extensive, a very notable quantity of wheat-starch mixed with the dust, whether recent or old; and, in rare instances, may be found the starch of oats, barley, and the potato.

It is evident, therefore, that the atmosphere holds in suspension a certain quantity of *wheat-starch* among its dust-corpuscles. This substance is met with in all places where it enters into articles of food, and it may readily be distinguished by its physical and chemical characters. The grains of which it consists are sometimes ovoid, sometimes spherical; in diameter they usually vary from 0·0140 to 0·0280mm. Besides these numerous extremely minute incipient granules, may be seen others less than 0·0028mm. in diameter. The larger grains are very rare; those of a medium size far more common, and the very minute ones extremely abundant. In the large granules the concentric layers and *hilum* may sometimes be readily distinguished. It is rather curious to remark that this starch, notwithstanding, in some instances, its secular existence, still affords all the physical and chemical properties of the recent substance. The only difference being that the very ancient presents a light-yellow tint. When boiled in water it swells and dissolves. Very weak hydrochloric acid has no effect upon it; it is coloured blue by iodine with greater or less intensity; and sometimes its colour disappears under the influence of light. One circumstance which has struck me, is, that among starch found in dust several centuries old, I have, from time to time, met with grains which *had spontaneously assumed a beautiful clear violet colour.* Was this due to the influence of time, or to the vicinity of the sea, or, lastly, according to M. Chatin, to the traces of the vapour of iodine contained in the atmosphere? Finally, that no doubt may be entertained with respect to the identity of this aërial fecula with ordinary starch, I would add, that its effect upon polarized light is the same, except that, when procured from a very ancient deposit, its polarizing property is less energetic.

It is evident that it is this fecula thus perfectly characterised by its physical and chemical properties, that M. De

Quatrefages has taken for the ova of microzoa. It is the most minute grains of this substance to which he refers when he states, that he "could easily recognise in the dust" several of those minute corpuscles of a spherical or ovoid form, well known to all micrographers, and which involuntarily suggest the idea of an extremely minute ovum.* This image is correct, but the illusion is at once dissipated by the slightest chemical test, which proves that the granules in question can be nothing else than either extremely fine amylaceous grains or siliceous particles, which I have frequently observed, and which are of such extreme tenuity, as under the microscope to present the appearance of transparent spherical granules.

Astonished at the comparative abundance of the amylaceous particles which I found among the atmospheric corpuscles, and in order to obtain a rigorous demonstration of the fact, I determined to examine dust of all ages and from all localities. I have investigated the monuments of our great cities, others on the sea-shore and in the desert; and, in the midst of the immense variety of corpuscles universally floating in the air, have almost everywhere met with starch in greater or less abundance. Gifted with an extraordinary self-conservative power, time seems scarcely to affect it.

However remote may be the antiquity of the atmospheric corpuscles, starch still recognisable is found among them. I have discovered its presence in the most inaccessible recesses of our old Gothic churches mixed with the dust, blackened by an existence of from six to eight centuries. I have even found it in the palaces and subterranean chambers of the Thebaid, where it would date probably from the epoch of the Pharaohs.

It may be affirmed, as a general proposition, that in all countries where wheat constitutes the basis of food, its starchy element penetrates everywhere with the dust, and is found mixed with it in more or less considerable quantity. It is more abundant in situations near the centre of towns and at a low level, whilst, in proportion as we go to greater distances from the great centres of population, and explore the more isolated monuments, does the starch become less and less abundant, and its grains more and more minute. I have been unable to detect any either in the Temple of Jupiter Serapis, situated on the shores of the Gulf of Baiæ, or in that of Venus Athor, placed on the confines of Nubia. Nevertheless, I have collected some in subterranean temples of Upper Egypt.

* 'Comptes rend.,' Paris, 1859, t. xlviii, p. 31.

It is remarked also, that in proportion to the elevation reached on mountains or on buildings, the amount of fecula mixed with the atmospheric detritus is diminished. In the Abbey of Fécamp, which is below the level of the ground, and situated in the middle of the town, starch abounds in the dust of its chapels. In the Cathedral of Rouen a considerable quantity is met with in the lower part of the tower of Georges d'Amboise, the proportion gradually diminishing as we ascend. Whilst still abundant in the ancient dust found in the roof of the choir, it becomes more and more rare when we mount into the spire. Very little is found at the base of the cast-iron pyramid, and not a single grain at its summit.

In an isolated chapel situated on the sea-shore, and built on a beach about 110 metres in elevation, the dust lodged on a statue was composed, in great part, of calcareous particles, derived from the sides of the mountain, and conveyed by the wind to the floor of the building, which is open day and night to pilgrims. In the same situation were also found a great number of scales of lepidopterous insects, which had, doubtless, often sought shelter there; but very rarely was a grain of starch perceived in the field of the microscope; whilst in the detritus of towns, on every trial, several grains of a medium size, and a considerable number of more minute dimensions, would have been noticed.

A battery also placed on the shore, and in an isolated situation, and which had not been opened for sixty years, afforded a black dust, which was as poor in starch as that of the chapel above mentioned. But the dust itself was of a wholly different nature, being composed almost entirely of very angular, transparent, colourless particles of silex. The starch was so scarce in this dust, that often not more than a single grain could be discovered in a dozen observations.

This dissemination is a phenomenon so general and so widely diffused in places where wheat is used for food, that there is no nook or corner into which starch does not insinuate itself with the air. It is found in everything, and in all situations into which the latter penetrates. The most obscure corners of our Gothic buildings have afforded this substance in the ancient dust which had never been disturbed in the memory of man. I have even found it in the *interior* of the cavity of the tympanum in the skull of a mummified dog which I procured from a subterranean temple in Upper Egypt. M. Ch. Robin, whose observations accord with mine, has discovered starch on the surface of the human skin, whence it may be procured by scraping

with a sharp instrument either in the dead body or of a living person.

All these observations, if it were needed, might be supported by biological proofs. Until the contrary can be shown experimentally, it may be said that the air is so rarely the vehicle of ova, and the dust so rarely their receptacle, that when the latter is subjected to an elevated temperature, it is no less fecund in animalcules than that which has not been heated; which would not be the case, were the hypothesis of aerian dissemination of ova founded in truth.

I have often repeated the following experiment. I have taken 3 grammes of an ancient dust, and placed it in a thin tube, heated to 215° C., in an oil-bath, for an hour and a quarter. The dust has afterwards been put into 30 grammes of artificial water, and the whole covered with a bell-glass. At the end of five days, and at a mean temperature of 20° C., the water was crowded with animalcules of large size—*Colpoda* and *Paramœcium*. The same result takes place with dust which has not been heated. What has been taken, therefore, for ova deposited from the atmosphere, was not really such; for, in that case, the dust which had been heated would have been infertile, the germs contained in it having been killed by a temperature of 215° C.

Another very simple experiment also proves that it is impossible to discover any living germ in the atmosphere. By means of an inhaling flask I caused 100 litres of air to pass through a safety tube whose bulb contained two cubic centimetres of distilled water. At the end of eight days I was unable to discover a single animalcule or ovum in this small quantity of water, in which the latter, themselves, could not escape observation, now that they have been completely described and measured, and are well known in several species. On the contrary, if I place in a cubic decimetre of distilled water 5 grammes of a fermentable substance, sheltered by a bell-glass having a capacity of one litre, at the end of eight days, and at a temperature of 18° C., the whole surface of the water is occupied by incalculable myriads of animalcules.

The memoir concludes with the detail of particular observations on dust collected in the following localities:

Tower of Georges d'Amboise, at Rouen. Interior of the Abbey at Fécamp. Ruins of Thebes. Tomb of Ramses II. Sepulchral chamber of the Great Pyramid. Temple of Venus Athor, at Philoe. Temple of Serapis, at Puzzuoli. Skull of a mummified dog, from the subterranean vaults of Beni-Hassan. The cabinet of a Jewish antiquarian at Cairo.

NOTES AND CORRESPONDENCE.

Angular Aperture.—My object in the paper on the subject of angular aperture, which you were good enough to insert (p. 256, last volume), was simply to facilitate the application of Mr. Lister's method of measurement, by showing how that method might be made available independently of the special apparatus usually considered requisite for this purpose. Mr. Hendry, therefore (p. 61, present volume), is mistaken if he supposes, as he seems to do, that I claim for the method, as described by me, *superiority in point of accuracy* to the method as usually practised. I do not do that, but I claim for it *equality* in this respect. An angle is determined quite as accurately by measurement of the sides of the triangle to which it belongs, as by measurement of its subtending arc. The use of two candles saves the trouble of moving the one candle, if one only is used, from one side of the field of view to the other; and the indication of these being properly placed will easily be found to be in exact accordance with the corresponding indication in Mr. Lister's method, as usually described.

But I am surprised at Mr. Hendry's statement, that "my rule gave no provision for angles exceeding 90°." I know of no ground for this statement. Take his fourth example:

Lights apart, 44 inches; distance of lens, 10 inches.

Hence $44 \div (10 \times 2) = 2{\cdot}2$. On reference to Hutton's Tables, I find this to be the tangent of 65° 33′. The aperture therefore is 131° 6′.

Mr. Hendry, perhaps, has only a table of *logarithmic* tangents. Very well. The logarithm of 2·2 is 0·3424, to which adding 10, to accommodate it to the tabular radius, it becomes 10·3424; and this is the logarithmic tangent of 65° 33′, as before.—M. Gray, 7, St. Paul's Villas, Camden Town, December 5th, 1859.

A New Cement for mounting Objects for the Microscope, either in dry cells or in fluid.—I have found that great rapidity is obtained in mounting objects in a cement made with as-

phaltum dissolved in *Benzine* or *Benzole* instead of turpentine, because it dries so quickly that a great many more objects can be mounted and finished in a day with it than with any other cement. I finish it off with a coat of asphalt in turpentine, to give it a smooth appearance.

It should be kept, like all cements for the mounting of microscopic objects, in a capped bottle, so that the brush is always soft and ready for use.

Benzole is also the most convenient solvent for removing superfluous balsam from the outside of the glass covers under which objects are mounted in that medium.—J. W. LAWRANCE, Peterborough.*

Registration of Objects.—I beg to subjoin notice of a simple mode of registering objects on slides, which was devised by me in India, and has answered all ordinary purposes so efficiently as to induce me to hope it may prove useful to microscopists.

It possesses three great advantages,—in requiring no separate apparatus, no special adjustment of slides or stage, and costing nothing. It is adapted for use with all the higher powers of the microscope. Although more readily available where the body of the instrument admits of lateral displacement, it may nevertheless be used where no such arrangement exists, by simply elevating the body to a sufficient height to allow of the bearings of the spot of light given off from the illuminator being accurately taken by the eye and hand.

Suppose an object to be in the centre of the field of vision. The body of the microscope is either turned aside or raised, as the case may be. The slide being securely clamped in position, two minute marks are made, with a writing diamond, perpendicularly above, and in a line horizontal with, the spot of light thrown upon the object by the condenser. The smaller the spot of light, of course, the more easy will it be to denote the situation of an object accurately. The slide is now removed, and the scratches are converted into short vertical and horizontal lines, varying in length according to convenience. These two lines are now joined together by a third line; and, lastly, a number is attached, at either angle thus formed, for entry in the note-book or catalogue of the observer.

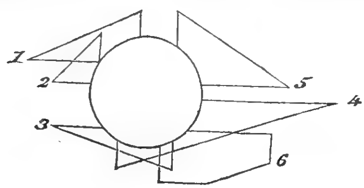
To find the object again, all that has to be done is to place the slide on the stage, and the body of the microscope being

* The addition of a little gold size to the solution of asphaltum in benzine will be found useful in rendering it less brittle.—[EDS.]

either turned aside or elevated as before, to move the slide to and fro, either by hand or stage movements, until the spot of light from the condenser indicates the spot at which the vertical and horizontal lines beyond the margin of the cover would intersect each other, if produced.

Of course, upon the accuracy with which the bearings have been taken will depend the facility of finding an object. But with ordinary care and a tolerably true eye, there is no difficulty.

The following diagram will show the mode of registry, and how it may be applied to any number of objects on the same slide—



The dots, it is almost unnecessary to remark, are appended merely with a view to indicate the points at which the objects to be registered occur.—G. L. Wallich.

Improvement of the Camera Lucida.—One of M. Nachet's ingenious applications of the prism to the microscope furnishes a hint for the improvement of the camera lucida, which I desire to bring under the notice of yourself and your readers. I refer to the arrangement described and figured on p. 706 of the second edition of Dr. Carpenter's work on the microscope. A prism of peculiar form is there seen, applied as a camera lucida to a vertical microscope.

To the arrangement in question, *as a whole*, I do not attach much importance; for, first, our English microscopes are generally of too tall a *build* to admit of being at all commodiously used in a vertical position for any length of time; and, secondly, if they could be commodiously so used, the stage would be in the way of the hand; while, moreover, the paper not being in the place where *it seems to be*, but away in front of the instrument, I venture to think that this would seriously interfere with the free use of the pencil in tracing the image.

It is to a small adjunct of M. Nachet's prism that I refer, as holding out a prospect of advantage; I mean the *piece*, marked E, in Dr. Carpenter's figure. It is well known that many—perhaps most—microscopists find considerable

difficulty in using the camera lucida as at present constructed, owing to the constrained position in which the eye must be held, half the pupil over and half beyond the edge of the prism. A partial remedy for this difficulty would be found in discarding the present form of prism, with its two reflecting surfaces, and using a prism having only one such surface, and drilling a small hole through it vertically. Through this hole the paper would be seen, while the image would be visible by the rays reflected from the inclined surface of the prism. The objection to this is that the hole would act, as regards the rays entering the prism, as an opaque rod, and so render useless the portion of the reflecting surface immediately behind it. A complete remedy for the difficulty is suggested by inspection of Dr. Carpenter's figure. Instead of making a hole in the prism, let there be attached to the centre of its inclined surface, by Canada balsam, an oblique segment of a small glass cylinder,* so that its base should be parallel to the upper surface of the prism. The effect now, on looking into the prism, will be precisely that of a a hole through it, without the drawback attendant upon an actual hole. The paper will be clearly seen through the prism and the cylinder, and the image by reflection from the inclined surface of the prism, the whole of which surface will now be available, with the exception of the spot where the cylindrical segment is attached, which, however, will be so small as not to be productive of any injurious effect. In fine, so far as I at present see, I feel warranted in expressing a belief that by the adoption of the arrangement now suggested, the difficulty hitherto attendant on the use of the camera lucida would be entirely prevented.

It has often been matter of wonder with me why our opticians continue to supply, for microscopical purposes, the prism with *two* reflecting surfaces. These are requisite in other applications of the camera, for the erection of the image. But in its application to the microscope we do not want this.† What we want, if we had a preference in the matter, is that the inversion caused by the first reflection be

* Dr. Carpenter calls Nachet's "piece E" a prism. I think he must be wrong. The *quasi* hole will be of the form of a direct section of the *piece* employed. A square prism would give a *square* hole, and a cylinder a *circular* one.

† A polished steel disc (Amici's *disc*) has sometimes been employed instead of the more usual Wollaston's camera. But the latter will always be preferred by those who draw from the microscope, simply for the reason that the image thrown on the paper by it corresponds in position with that viewed through the microscope.—[Eds.]

left alone. I should think that a prism with only one reflecting surface would be much more easily worked than one with two. A prism of the latter form, however, is spoiled by the slightest clipping of the edge; while, in the arrangement I have proposed, the edge does not come into use—and it might perhaps be found more advantageous in the working to have the edges truncated.—P. GRAY, 7, St. Paul's Villas, Camden Town, N.W.

On the RARER *and* UNDESCRIBED SPECIES *of* DIATOMACEÆ. By T. BRIGHTWELL, F.L.S. Part II.

ERRATA ET CORRIGENDA.

I regret to find the following errors have crept into my last paper which need correction.

TEXT.

Page 94, line 4, *insert* reference to plate "(Pl. VI, fig. 15)."
" 94, " 8, *for* "fig. 15," *read* "18."
" 94, " 4 from bottom, *instead of* "*Aulacodiscus*," *read* "*Auliscus sculptus* = *A. cælatus*, Bailey."
" 95, line 1, *for* "*Aulacodiscus*," *read* "*Eupodiscus*."
" 95, " 6, "*Aulacodiscus lævis*." I find this form has been named and distributed by Dr. Arnott as "*A Kittoni*;" the specific name of "*lævis*" must, therefore, be cancelled, and "*Kittoni*" substituted.
" 95, line 19, the specific name should be "*coscinodiscus*," *instead of* "*pyxidicula*."
" 96, line 6, *for* "·019 to 0·3," *read* "·0019 to ·0030."

One general error runs through all the measurements; they require an additional ·0 in front.

DESCRIPTION OF PLATES.

Plate V.

Fig. 2, *insert* specific name "*trilingulatus*."
" 4, *for* "*pyxidicula*," *read* "*coscinodiscus*."
" 5, *for* "*Aulacodiscus*," *read* "*Auliscus*."
" 6, *insert* specific name "*coronatus*."
" 7, " " " "*marginatus*."
" 9, " " " "*cervinus*."
" 10, *for* "*Aulacodiscus*," *read* "*Eupodiscus*."

Plate VI.

Fig. 11, *insert* specific name "*radiata*."
" 12, " " " "*semiplanus*."
" 13, " " " "*Kittoni*."
" 15, " " " "*spinosa*."
" 16, " " " "*stylorum*."
" 17, *for* "*Eupodiscus*," *read* "*Actinoptychus interpunctatus*."

PROCEEDINGS OF SOCIETIES.

Microscopical Society, *January* 11*th*, 1860.

Dr. Lankester, President, in the chair.

The minutes of the preceding meeting were read and confirmed.

J. A. Tulk, Esq., 5, East Preston-street, Edinburgh; J. C. Forsyth, Esq., Stoke-upon-Trent; and George Kelly, Esq., 9, Sutherland-gardens, Maida-vale, were balloted for, and duly elected members of the Society.

The following papers were read:

1. 'On the Localities of Diatomaceæ,' by Mr. Norman. ('Trans.,' p. 59.)

2. 'On the Reproduction of Confervoid Algæ,' by Mr. Druce. ('Trans.', p. 71.)

The following letter, addressed to the President, was read:—

"My dear Sir,—I send you three slides of the same object.

"No. 1, mounted in balsam, without any preparation except washing away the salt water.

"No. 2, the same burned on the cover, and mounted dry.

"No. 3, the same neither boiled nor burned, and mounted in fluid. It is probable that, in this last, all the objects may, during the transit, be deposited on one side of the cell, but a little shaking will perhaps cause them to become again scattered, as they were when mounted.

"The first time that it came under my notice, it was sent me, 11th September, 1858, by the Rev. R. Taylor, of Bedlington, from the coast of Northumberland. I afterwards received it from Mr. Mansfield Browne, of Liverpool, collected on that coast. Thereafter it was sent me by Mr. Roper, from the Norfolk coast; by Mr. G. Norman, of Hull, from near the mouth of the Humber; and the other day, I received an immense quantity of it from Mrs. Macdonald, of St. Andrews, Fifeshire.

"In all these cases it is found on very shallow pools among the sands; it floats on the surface and forms extensive patches. If sand adheres, it is easily separated by a slight shaking in the bottle in which it is collected.

"Some have supposed it a diatom allied to *Biddulphia Bayleyi*. From its filamentous nature, and having long spines or cilia, it might, if diatomaceous, be approached to *Biddulphia;* but it takes in turpentine and balsam when dried without being boiled or burned. Now this can only take place on the supposition either that there are no partitions (or valves at the joint—in other words, that the tube is continuous), or that the wall is porous; either of which is contrary to its being a diatom at all.

"Some of my correspondents suppose it to be the exuviæ of an annelid; but no one can point out either genus or species.

"An object of such abundance on our coasts (at St. Andrews I am informed that a pint of it could have been collected in a few minutes) must surely be well known to the London microscopists; and therefore I send you the slides in the hope that, through its members, you will be able to throw some light on the point.

"I shall send a supply of the object itself to Mr. J. T. Norman, the well-known preparer of microscopic objects; so that any one requiring slides may have them from him. They are best seen on the cover, dry, and not burned; but, unless burned, they are apt to imbibe damp, and the slide becomes useless in a year or two. I therefore, myself, prefer them when mounted dry, after being burned.

"Yours truly,

"G. Walker Arnott."

"Victoria-terrace,
"Dowanhill, near Glasgow."

Josh. Gratton, Esq., and R. Beck, Esq., were appointed auditors of the Treasurer's account.

February 8th, 1860.

ANNIVERSARY MEETING.

Dr. Lankester, President, in the chair.

The minutes of the preceding meeting were read and confirmed.

Reports from the Council and the Library Committee were read, together with the Auditors' Report on the Treasurer's accounts; there remaining in his hands a balance of £25 16*s*. 10*d*.

Resolved that these Reports be received and adopted.

R. Lloyd, Esq., 69, Holborn-hill; and H. W. Elphinstone, Esq., 45, Cadogan-place, were balloted for, and duly elected members of the Society.

The President delivered an address on the progress of the Society, and of microscopical science generally, during the past year.

Resolved, that the address now read be printed and circulated in the usual manner, with the Reports of the Council, the Library Committee, and the Auditors.

March 14*th*, 1860.

George Jackson, Esq., in the chair.

John Shepperd, Esq., 11, Sussex-place, Regent's-park; and Thomas Ketteringham, Esq., 51, Coleshill-street, Chelsea, were balloted for and duly elected members of the Society.

The following papers were read:—

'On the Development of the Diatom-valve,' by Dr. Wallich. ('Trans.,' p. 129.)

'On Asterolampra, and some other species of Diatomaceæ,' by Dr. Greville. ('Trans.,' p. 102.)

'On the Amœboid Conditions of *Volvox globator*,' by Dr. Hicks. ('Trans.,' p. 99.)

'On a New Zoophyte,' by Dr. Allman. ('Trans.,' p. 125.)

ZOOPHYTOLOGY.

SHETLAND POLYZOA. Collected by MR. BARLEE. (*Continued.*)

2. *L. Barleei*, n. sp. Pl. XXVI, figs. 1, 2.

L. cellulis ovoideis, convexis, superficie granulosâ; orificio orbiculari infra sinuato, peristomate simplici elevato; ovicellulis decumbentibus adnatis, ad marginem supra perforatis.

Cells ovoid, convex; surface granular; orifice orbicular with a sinus below, peristome thin, raised; ovicells adnate, decumbent, punctured round the border above.

Hab. Shetland, *Barlee;* on shell.

3. *L. canthariformis*, n. sp. Pl. XXVI, figs. 3, 4.

L. cellulis late ovoideis, superficie granulosâ, punctatâ, nitidâ; orificio magno, suborbiculari seu irregulari, peristomate producto, sæpius infundibuliformi, integro.

Cells broadly ovoid, surface granular, punctate, shining; orifice large, suborbicular, oblong, or irregular; peristome much produced, often infundibuliform, entire.

Hab. Shetland, *Barlee;* on shell.

4. *L. umbonata*, n. sp. Pl. XXVII, fig. 1.

L. cellulis oblongis, seriatis, lineâ elevatâ sejunctis; ad latera perforatis, medio umbonatis, et juxta orificium mediò avicularium mandibulo semicirculari horizontali gerentibus; orificio suborbiculari, infra paullulum constricto, peristomate simplici spinis 4; supra armato; ovicellulis umbonatis vittamque parvam utrinque ostendentibus.

Cells oblong, serial, parted by a narrow raised line, punctured on the sides, and sometimes in front, with smaller pores; furnished with a central umbo, and having a prominent avicularium with a semicircular horizontal mandible immediately below the orifice; orifice suborbicular, or sometimes contracted below; peristome simple, with four spines above; ovicell large, rounded, umbonate, with a small vitta or depressed area placed obliquely on each side below.

Hab. Shetland, *Barlee;* on stone.

The only species with which this can well be confounded is *L. verrucosa,* which possesses a similar suboral avicularium, but always wants, I believe, the central umbo on the cell and on the ovicell, as well as the vittæ on each side of the latter, which are not unlike those on the ovicell of *L. figularis,* only smaller. In *L. verrucosa,* also, the ovicell is punctured,

whilst in *L. umbonata* its walls are apparently entire. The umbo on the ovicell, it may be remarked, is merely that belonging to the cell in front of which the ovicell rises.

5. *L. bella*, n. sp. Pl. XXVII, fig. 2.

L. cellulis ovoideis, perforatis; orificio suborbiculari, infra sinuato, denticulum internum bifidum ostendenti; peristomato, elevato, subinde incrassato, inermi; ovicellulis rotundatis perforatis.

Cells ovate, punctured; orifice orbicular, with a spout-like sinus below, within which is a rather large, bifid denticle; peristome raised, often thickened; ovicell subglobose, punctured.

Hab. Shetland, *Barlee;* on shell.

This is the species which I doubtfully termed *L. Landsborovii,* when the account of Mr. Barlee's species was read at the British Association. It is clearly, however, not that species as now understood, however much the figures here given may seem to correspond with that of *L. Landsborovii,* in Plate LXXXVI, of the 'British Museum Catalogue.' That figure was taken from the only specimen of *L. Landsborovii* contained in the Johnstonian Collection, and which was the sole representative of the species I had then seen. Since then, however, having received numerous and more perfect specimens, I have been able to determine the characters of the species more precisely; and Fig. 1, Plate CII, of the 'British Museum Catalogue,' erroneously referred to *L. reticulata,* may perhaps be taken as representing its typical form.

The differences between *L. bella* and *L. Landsborovii* consist—

1. In the absence in the former of the intercellular raised line, and

2. In the absence of any avicularian organ on the lower border of the orifice.

From *L. reticulata* and *L. pertusa* the differences are too obvious to require more particular notice.

The other species of *Lepralia* which occur in Mr. Barlee's collection are—

6. *L. Pallasiana*, Moll.

7. *L. bispinosa*, Johnston.

8. *L. granifera*, Johnston.

9. *L. ringens*, Busk.

10. *L. discoidea*, Busk. Pl. XXVII, figs. 4, 5.

The figure of this species, which in some respects closely approaches an *Alysidota,* was inadvertently placed on the stone, before I remembered that it had been already figured in ('Zoophytology') Pl. XXII, figs. 7, 8, from specimens

collected in Madeira by Mr. J. Y. Johnson. As I am unable to discover any satisfactory specific distinction between the northern and southern forms, I am induced to consider them identical.*

Other species belonging to the family *Membraniporidæ,* which occur in Mr. Barlee's collection, are—

1. *Membranipora Rosseli,* Savign.
2. " *Pouilletii,* Savign.
3. " *spinifera,* Alder.
4. *Alysidota Alderi,* Busk, which appears to be very abundant.

* In the paper read at the meeting of the British Association, this species was termed *Alysidota conferta.*

(To be continued.)

ZOOPHYTOLOGY.

DESCRIPTION OF PLATES XXVI & XXVII.

PLATE XXVI.

Fig.

1 and 2.—*Lepralia Barleei,* p. 143.

3 and 4.—*L. canthariformis,* p. 143.

PLATE XXVII.

1.—*Lepralia umbonata,* p. 143.

2 and 3.—*L. bella,* p. 144.

4 and 5.—*L. discoidea,* p. 144.

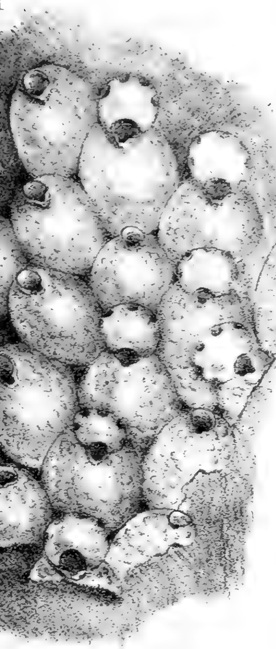
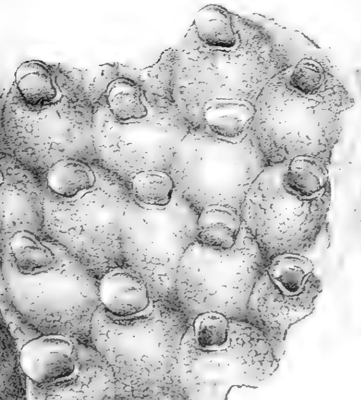
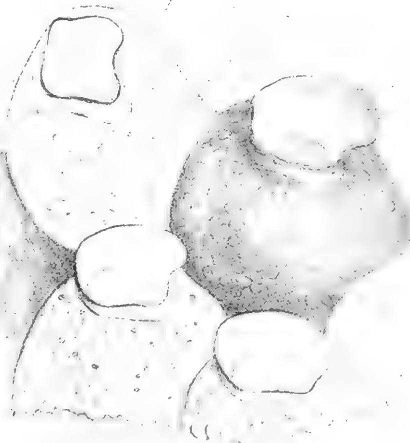


Fig.3





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ZOOPHYTOLOGY

Plate XXVII

Fig 1

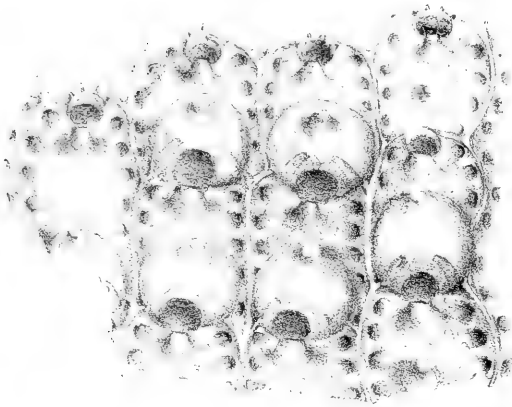
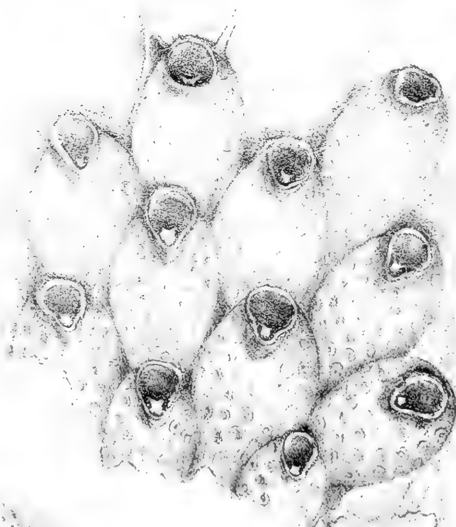


Fig 5

Fig 2



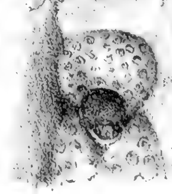
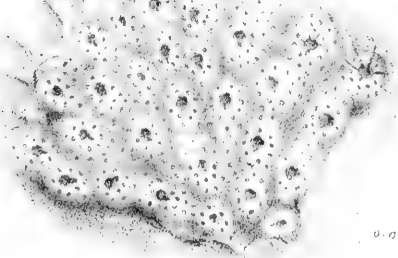
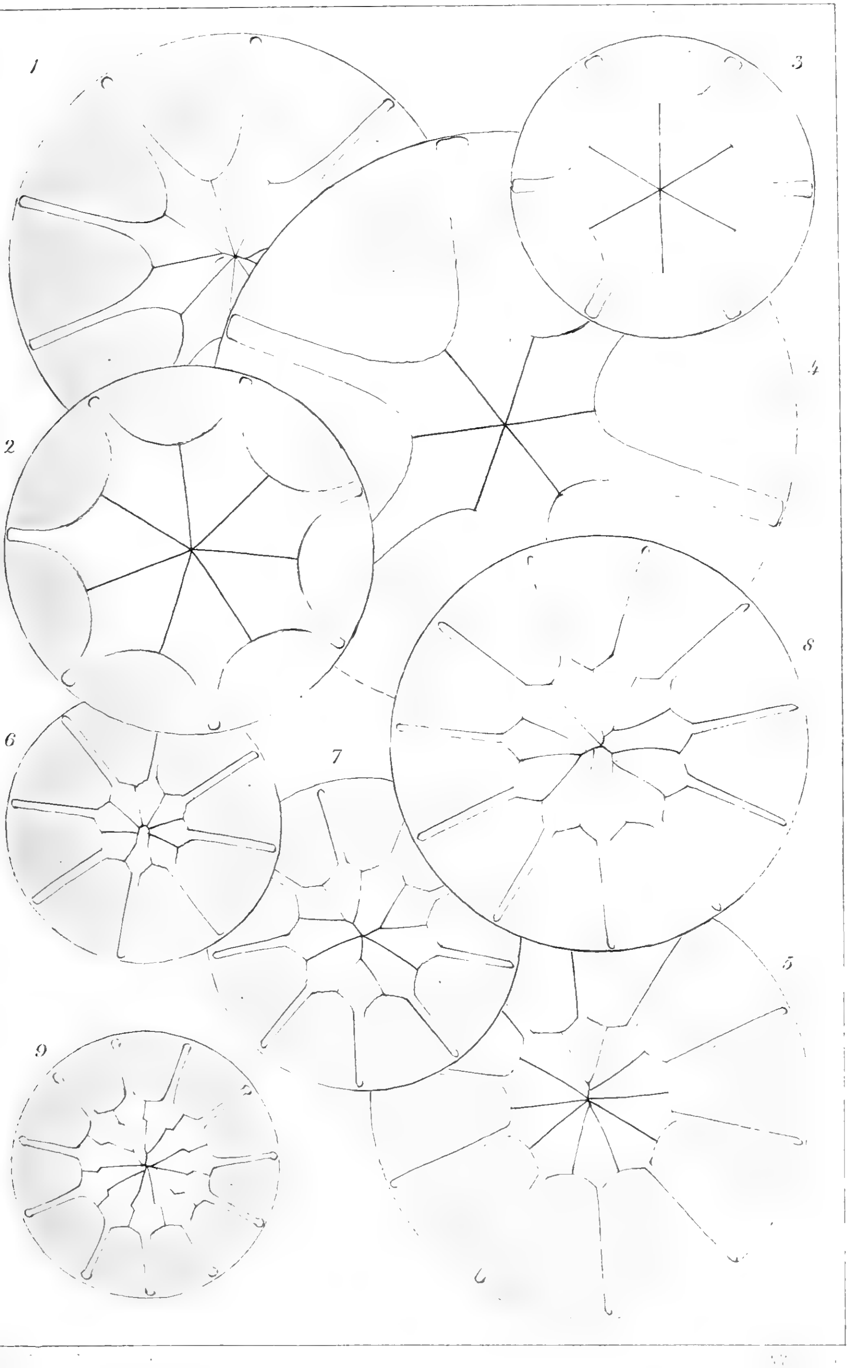


Fig 3

Fig 4



G. Busk del — W West imp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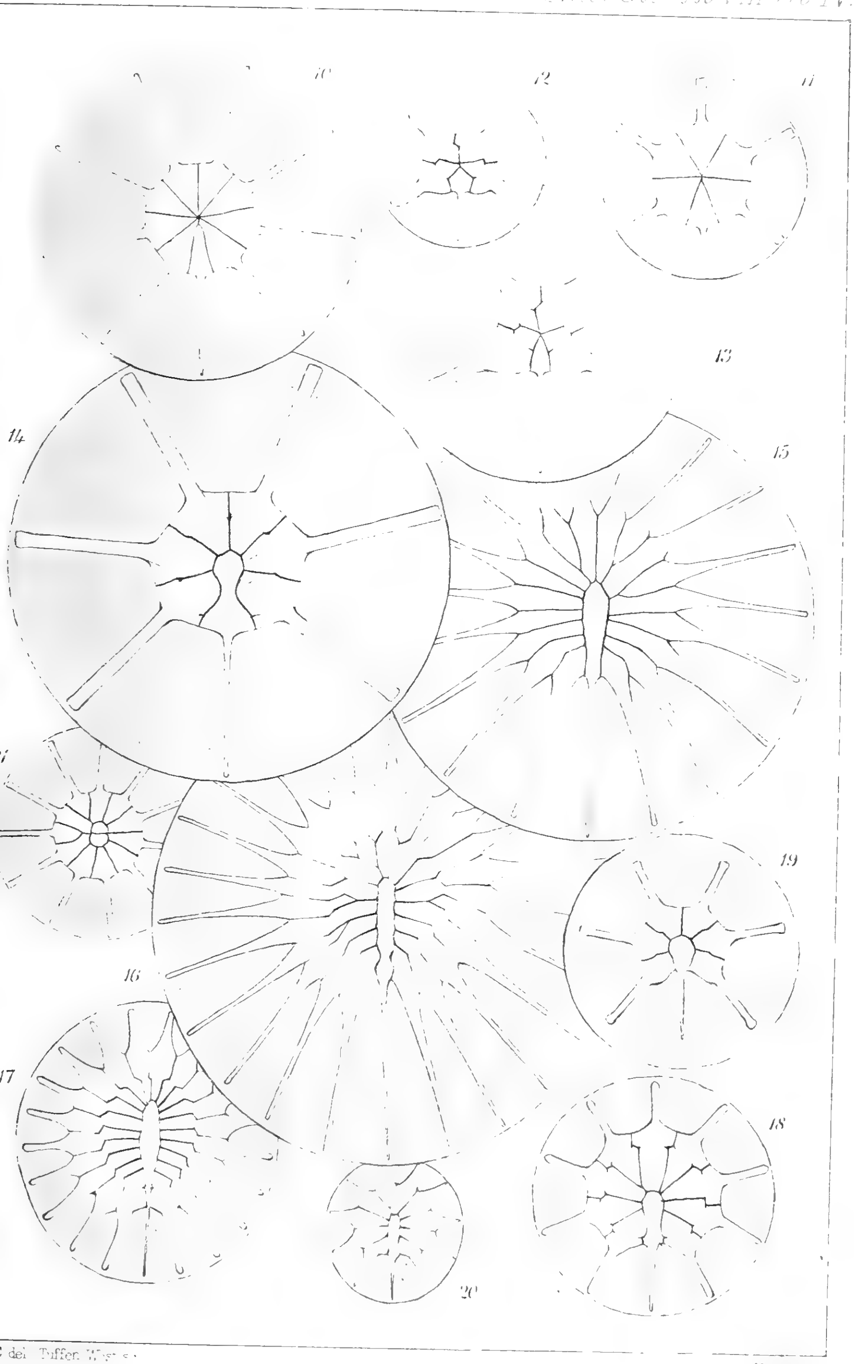

del. Tuffen West sc.

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